GAS TECHNOLOGY INSTITUTE

Cement-Lock Demo Plant

Ecomelt - Passaic River Sediment

Cement-Lock® Technology for Decontaminating Dredged Estuarine Sediments

Topical Report on Beneficial Use of Ecomelt from Passaic River Sediment at Montclair State University, New Jersey

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Submitted to:

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EXECUTIVE SUMMARY

This topical report on "Beneficial Use of Ecomelt from Passaic River Sediment at Montclair State University, New Jersey" describes the work conducted as part of the overall program "Cement-Lock®[1] Technology for Decontaminating Dredged Estuarine Sediments." The work was performed by the Gas Technology Institute (GTI, Des Plaines, IL) and its wholly owned subsidiary, ENDESCO Clean Harbors (ECH, Des Plaines, IL) for the U.S. Environmental Protection Agency Region 2 and the U.S. Army Corps of Engineers (New York District) with technical and contractual support through Brookhaven National Laboratory (BNL, Contract No. 725043). Funding for the beneficial use task was provided to GTI from BNL through the federal Water Resources Development Act.

Beneficial Use Project: CTLGroup (formerly Construction Technology laboratories, Skokie, IL) conducted tests on a small sample of Ecomelt from Passaic River sediment to determine its suitability as a partial replacement for Portland cement in concrete. CTLGroup also prepared a batch of concrete made with Ecomelt (40% replacement of Portland cement) and conducted specific concrete-related tests on the concrete produced. The objective of these tests was to characterize the concrete and establish a mix design for the beneficial use project at Montclair State University (MSU), Montclair, New Jersey. For the beneficial use project, a length of sidewalk (165 feet long by 6 feet wide) will be poured on the MSU campus. The results of tests conducted by CTLGroup are summarized below.

CTLGroup also ground about one ton of Ecomelt to cement fineness (<50 μm) using a batch ball mill. The ground Ecomelt will be used for producing a batch of concrete for pouring a length of sidewalk (165 feet long by 6 feet wide) at MSU. An Acceptable Use Determination (AUD) was issued by the New Jersey Department of Environmental Protection (NJ-DEP) to ECH for the beneficial use project. The one ton of Ecomelt in five 55-gallon drums was shipped to MSU on May 1, 2008.

[1] Inquiries regarding commercial application of Cement-Lock® Technology may be directed to the technology owner, Volcano Group LLC, 557 North Wymore Road, Suite 100, Maitland, FL 32751, phone (877) 326-6358 / (877) ECOMELT.

Characterization of Ecomelt from Passaic River Sediment: The sample of Ecomelt was finely ground and blended with ordinary Portland cement at a 40:60 Ecomelt/Portland cement weight ratio. The blended cement was subjected to compressive strength tests according to ASTM C 595 specifications for blended cements. The results (Table ES-1) showed that after 7 and 28 days of curing, the mortar samples made with 40:60 Ecomelt/Portland cement blend exceeded the compressive strength of the control mortar specimens.

Based on the results, CTLGroup concluded that "the Ecomelt appears to be potentially suitable as a 40% replacement for Portland cement in concrete for use in general construction and/or where high early strength is required." CTLGroup further recommended that additional tests be conducted on a larger batch of Ecomelt so that an appropriate concrete mix design could be developed for a specific application.

Table ES-1. Results of Compressive Strength Tests Conducted on Mortar Samples Made with Ecomelt/Portland Cement Blend (40:60 wt %) and Control Cement

Days of Curing	Ecomelt/Portland Cement Blend Mortar	Control Mortar
	Compressive Strength, psi (MPa)	
1	1,800 (12.4)	--
3	3,680 (25.4)	3,690 (25.5)
7	5,300 (36.5)	4,860 (33.6)
28	7,550 (52.1)	6,900 (47.8)

Subsequently, ECH provided several hundred pounds of Ecomelt from Passaic River sediment to CTLGroup to conduct the recommended tests, including compressive strength, flexural strength, drying shrinkage, freeze-thaw testing, deicing-scaling, and chloride permeability. The compressive strength tests results (Table ES-2) showed that after 28 and 56 days of curing, the Ecomelt/Portland cement blend achieved 5,700 psi; while the control achieved 5,950 psi. After 56 days of curing, the compressive strength results were the same. These results show that concrete made with the 40:60 Ecomelt/Portland cement blend may require an accelerator for high early strength applications.

The results of the drying shrinkage test showed that the concrete made with the Ecomelt/Portland cement blend had a slightly lower shrinkage than the control.

Table ES-2. Results of Compressive Strength Tests Conducted on Concrete Samples Made with Ecomelt/Portland Cement Blend (40:60 wt %) and Control Cement

Days of Curing	Ecomelt/Portland Cement Blend Concrete	Control Concrete
	Compressive Strength, psi (MPa)	
4	2,850	4,500
7	3,450	4,800
28	5,700	5,950
56	6,650	6,650

Also, after 301 freeze-thaw cycles, the Ecomelt/Portland blend specimens had a slightly higher relative dynamic modulus of elasticity of 91 percent compared to 90 percent for the control.

The Ecomelt/Portland blend specimens showed lower resistance to deicer scaling than the control.

The Ecomelt/Portland blend specimens showed “Very Low” chloride permeability compared to “Moderate” chloride permeability for the control, where a lower result is preferred.

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I. BENEFICIAL USE DEMONSTRATION OF CEMENT-LOCK® ECOMELT®

The beneficial use project with Ecomelt produced from Passaic River sediment at the Cement-Lock demonstration plant (Bayonne, NJ), and chemical and physical characterization of Ecomelt for the beneficial use project are described below.

Beneficial Use Project

The objective of the beneficial use project is to demonstrate that the Ecomelt produced from Passaic River sediment can be used successfully and in an environmentally acceptable manner in a general construction project. For this beneficial use project, Ecomelt will be used as a partial replacement for Portland cement in the production of a batch of concrete. The concrete will be used to pour a length of sidewalk (165 feet long by 6 feet wide) at Montclair State University, Montclair, New Jersey. The concrete pouring/placement is tentatively planned for June/July 2008.

To this end, about one ton of Ecomelt from Passaic River sediment was dried and ground to cement fineness (<50 µm) in a batch ball mill. The batch grinding work was performed at the laboratories of CTLGroup (formerly Construction Technology Laboratories, Skokie, IL). CTLGroup also conducted the Ecomelt characterization testing described below. The two reports prepared by CTLGroup for this work are included in Appendix A.

As part of their work, CTLGroup developed a mix design for the Ecomelt that can be used for the beneficial use project. The mix design (Table 1) specifies the amounts of Ecomelt, Portland cement, sand, gravel, water, and admixtures that must be mixed together to yield concrete with the desired properties for the beneficial use application. Ecomelt is used as a 40 percent (by weight) replacement for Portland cement in the mix design.

A formal application for Acceptable Use Determination (AUD) was submitted to New Jersey Department of Environmental Protection (NJ-DEP) for the beneficial use project. The AUD application, supporting documentation, and AUD issued by NJ-DEP are included in Appendix B. The one ton of Ecomelt in five 55-gallon drums was shipped to MSU on May 1, 2008.

Characterization of Ecomelt from Passaic River Sediment

CTLGroup conducted tests on samples of Ecomelt from Passaic River sediment to determine suitability as a partial replacement for Portland cement in concrete. The objective of these tests was to characterize the concrete and establish a mix design for the beneficial use project at Montclair State University. The results of these tests are summarized below.

Table 1. Mix Design for Ecomelt/Portland Cement Concrete Batching

Mixes	**Control**	**Ecomelt/Portland**
Type I cement (Portland), wt %	100	60
Ecomelt, wt %	0	40
Mix Design		
Cement (Continental), lb	564	338.4
Ecomelt (GTI), lb	0	225.6
1” Coarse Aggregate (Vulcan), lb	1875	1875
Fine Aggregate (McHenry Sand), lb	1256	1222
Water (City), lb	255	255
Air Entraining Agent (Daravair), oz/cwt	1.00	2.55
Water Reducing Agent (WRDA 64), oz/cwt	4.25	5.00
Fresh Properties		
Fresh Density, lb/ft^3	145.4	145.4
Slump, inches	4.00	4.00
Air content, %	6.2	5.7
Yield, ft^3/yd^3	27.2	26.9
Time of Setting		
Initial, hr:min	6:21	6:33
Final, hr:min	7:37	8:19

The initial sample of Ecomelt was finely ground and blended with ordinary Portland cement at a 40:60 Ecomelt/Portland cement weight ratio. Forty percent was selected because it represents the maximum replacement of Portland cement by a pozzolanic material allowed under ASTM C 595 (Standard Specification for Blended Hydraulic Cements). The blended cement was subjected to compressive strength tests according to ASTM C 109 (mortar samples) and the results compared with C 595 specifications. The results (Table 2) showed that after 7 and 28 days of curing, the mortar samples made with 40:60 Ecomelt/Portland cement blend exceeded the compressive strength of the control mortar specimens as well as the ASTM C 595 specifications for blended cement.

In their report, CTLGroup concluded that “the Ecomelt appears to be potentially suitable as a 40% replacement for Portland cement in concrete for use in general construction and/or where high early strength is required." CTLGroup further recommended that additional tests be conducted on a larger batch of Ecomelt so that an appropriate concrete mix design can be developed for a specific application.

Table 2. Results of Compressive Strengths Tests Conducted on Mortar Samples Made with Ecomelt/Portland Cement Blend (40:60 wt %) and Control Cement

Days of Curing	Ecomelt/Portland Blended Cement Mortar	Control Mortar	ASTM C 595 Specification
	Compressive Strength, psi (MPa)		
1	1,800 (12.4)	--	--
3	3,680 (25.4)	3,690 (25.5)	1,890 (13.0)
7	5,300 (36.5)	4,860 (33.6)	2,900 (20.0)
28	7,550 (52.1)	6,900 (47.8)	3,620 (25.0)

Subsequently, ECH provided several hundred pounds of Ecomelt from Passaic River sediment to CTLGroup to conduct the recommended larger-scale tests. The tests are standard methods from the American Society for Testing and Materials (ASTM) and include:

- Standard Test Method for Time of Setting of Concrete Mixtures by Penetration Resistance (ASTM C-403)
- Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens (ASTM C-39)
- Standard Test Method for Flexural Strength of Concrete (Using Simple Beam with Third-Point Loading) (ASTM C-78)
- Standard Test Method for Length Change of Hardened Hydraulic-Cement Mortar and Concrete (AST C-157)
- Standard Test Method for Resistance of Concrete to Rapid Freezing and Thawing (ASTM C-666)
- Standard Test Method for Scaling Resistance of Concrete Surfaces Exposed to Deicing Chemicals (ASTM C-672)
- Standard Test Method for Electrical Indication of Concrete's Ability to Resist Chloride Ion Penetration [ASTM C-1202 (AASHTO T 277)]

The results of these tests are discussed in detail below. As mentioned above, the complete reports prepared by CTLGroup are included in Appendix A.

Time of Setting of Concrete: The initial and final setting times for the Ecomelt/Portland cement blend concrete and Portland cement concrete control samples were determined according to ASTM C 403. The initial setting times (refer to Table 1) were similar for the control and test mix at 6:21 and 6:33 (hr:min), respectively. The final setting times were 7:37 and 8:19 (hr:min) for the control and test mix, respectively. Pozzolanic materials such as Ecomelt are typically slow to react, but eventually achieve characteristics similar to those of ordinary Portland cement. In the event that a quicker setting time is required, an accelerator such as calcium chloride could be added to the concrete mix.

Compressive Strength: The compressive strengths of cylindrical concrete specimens (4 inches in diameter by 8 inches long) were determined after 4, 7, 28, and 56 days of curing. The results presented in Table 3, show that the compressive strengths of the Ecomelt/Portland cement blend specimens were 2,850 psi, 3,450 psi, 5,700 psi, and 6,650 psi, respectively. The compressive strengths measured were 63 percent, 72 percent, 96, and 100 percent of the control after 4, 7, 28, and 56 days, respectively. The Ecomelt-based blended cement achieved compressive strength at a slower rate than the control. However, it does gain strength with time. Figure 1 shows a specimen of Ecomelt-based blended cement concrete ready for compressive strength testing. Figure 2 shows the specimen after testing. It showed a typical conical break.

Table 3. Results of Compressive Strengths Tests Conducted on Concrete Samples Made with Ecomelt/Portland Cement Blend (40:60 wt %) and Control Cement

Days of Curing	Ecomelt/Portland Blended Cement Concrete	Control Concrete
	Compressive Strength, psi (MPa)	
4	2,850	4,500
7	3,450	4,800
28	5,700	5,950
56	6,650	6,650

Flexural Strength: The flexural strengths (modulus of rupture) of concrete block specimens were determined after 4, 7, and 28 days of curing to be 510 psi, 660 psi, and 910 psi, respectively. The flexural strengths measured were 74 percent, 89 percent, and 99 percent of the control after 4, 7, and 28 days, respectively. Figure 3 shows a specimen of Ecomelt-based blended cement concrete ready for flexural strength testing. Figure 4 shows the specimen after testing. The specimen fractured at the tension surface within the middle one-third of the span length.

Drying Shrinkage: The drying shrinkage characteristics of the control and test mix concrete specimens were determined according to ASTM C 157. After 56 days of curing, the control

Figure 1. Concrete Cylinder of Ecomelt-Based Blended Cement in Position for Compressive Strength Testing at CTLGroup Laboratories

Figure 2. Concrete Cylinder of Ecomelt-Based Blended Cement After Compressive Strength Testing at CTLGroup Laboratories

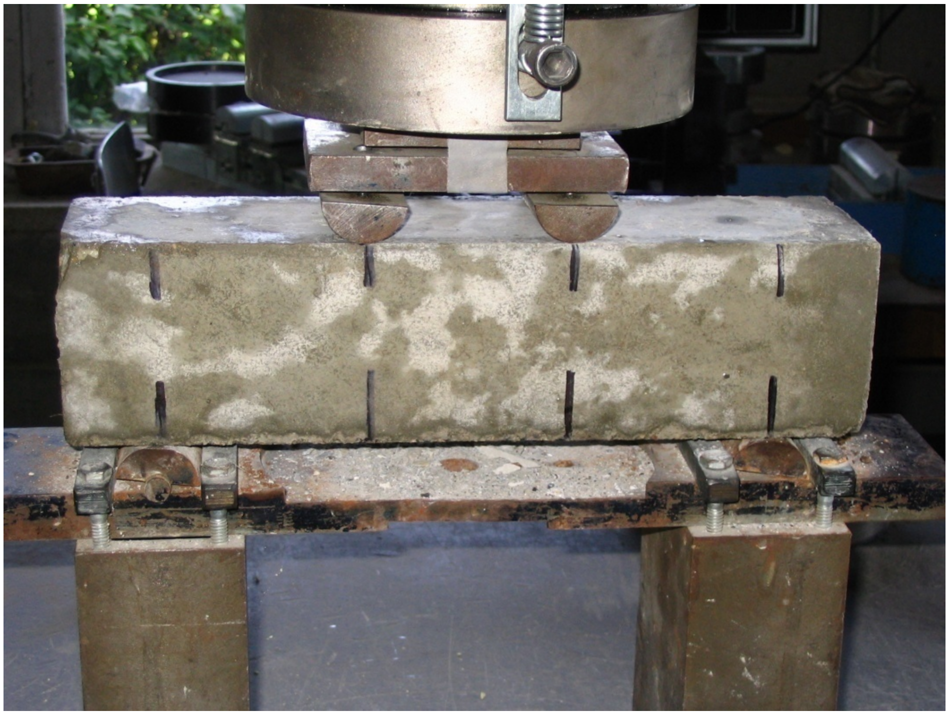

Figure 3. Concrete Block of Ecomelt-Based Blended Cement in Position for Flexural Strength Testing at CTLGroup Laboratories

Figure 4. Concrete Block of Ecomelt-Based Blended Cement After Flexural Strength Testing at CTLGroup Laboratories

specimen showed a shrinkage value of -0.038 percent. The Ecomelt test specimen showed a shrinkage value of -0.031 percent. As less shrinkage is preferred, this indicates that the Ecomelt-based specimen has a slightly lower shrinkage characteristic than that of the control.

Freeze-Thaw Testing: In the freeze-thaw test (ASTM C 666), concrete block samples are cyclically cooled from 40° to 0°F and then heated to 40°F over the course of 2 to 5 hours (1 cycle). The freeze-thaw apparatus is usually automated and can be operated around the clock. The test samples are subjected to up 300 freeze-thaw cycles or until the relative dynamic modulus of elasticity falls below 60 percent. The test samples are periodically weighed and measured. After 301 freeze-thaw cycles, the concrete blocks made with Ecomelt/Portland cement showed a relative dynamic modulus of elasticity of 91 percent; whereas the control specimens showed a relative dynamic modulus of elasticity of 90 percent. The freeze-thaw resistance characteristic of the Ecomelt-based blended cement was similar to that of the control. Figure 5 shows the concrete test specimens in the freeze-thaw apparatus (cover open).

Figure 5. Concrete Blocks of Ecomelt-Based Blended Cement Being Subjected to Freeze-Thaw Cycles at CTLGroup Laboratories

Scaling Resistance to Deicer Chemicals: Concrete test specimens were subjected to ASTM C 672 to determine resistance of the concrete surface to scaling due to exposure to deicer chemicals, specifically calcium chloride ($CaCl_2$). The results showed that the deicer chemical attacked the Ecomelt/Portland cement concrete samples more aggressively than the control samples. After 50 cycles, the Ecomelt/Portland cement samples showed a cumulative mass loss of 0.4 lb/ft^2, while the control showed a cumulative mass loss of 0.04 lb/ft^2.

Chloride Ion Penetration: Concrete test specimens were subjected to ASTM C 1202 (AASHTO T 277) to determine the concrete ability to resist chloride ion penetration. The Ecomelt/Portland cement blend specimens showed "Very Low" chloride ion permeability compared to "Moderate" chloride ion permeability for the control, where a lower result is preferred.

Summary: A mix design for concrete using Ecomelt as a partial replacement for Portland cement was developed for the beneficial use project. The major chemical and physical characteristics of concrete made with Ecomelt/Portland cement blend have been determined.

The time of setting for the Ecomelt/Portland cement blend was slower than that of the control. The compressive and flexural strengths were similar to those of the control, but typical of pozzolanic materials took longer to achieve. Drying shrinkage and freeze-thaw results were similar to those of the control.

Resistance to deicer scaling was lower for the Ecomelt/Portland cement specimen compared to the control. CTLGroup offered several explanations for this result: The test sample may have lower entrained air content than the control, which would result in lower resistance to the deicer salt. Pore water bleeding to the concrete specimen surface may evaporate leaving calcium hydroxide [$Ca(OH)_2$] to react with CO_2 in the atmosphere generating calcium carbonate ($CaCO_3$), which is fairly weak. Also, finishing the concrete sample may have disturbed the air entrained at the surface. CTLGroup suggested that reducing the Ecomelt replacement from 40 to 30 percent of the Portland cement requirement could reduce scaling. They also suggested that using a curing compound on the concrete surface after pouring could reduce scaling.

Resistance to chloride ion penetration was better with the Ecomelt/Portland cement specimen than the control.

II. SUMMARY AND CONCLUSIONS

The beneficial use project with Ecomelt made from Passaic River sediment during the Extended Duration Test campaigns at the Cement-Lock demonstration plant (Bayonne, NJ) will be conducted at the campus of Montclair State University. A batch of concrete will be produced and poured for a length of sidewalk on the campus. Following are a summary of the results and conclusions from the beneficial use task:

- The physical and chemical properties of Ecomelt samples from Passaic River sediment have been evaluated by CTLGroup. The results show that Ecomelt can be used as a partial replacement (up to 40 wt %) for Portland cement in a general construction project.
- The Ecomelt/Portland cement blend achieved compressive strength at a lower rate than did the control sample. However, after 56 days of curing, the compressive strengths of both Ecomelt/Portland cement blend and control specimens were the same.
- Time of setting was longer for the Ecomelt/Portland cement blend than that of the control – typical of pozzolanic materials.
- CTLGroup prepared a mix design for the beneficial use of the dried and ground Ecomelt to be incorporated into a batch of concrete.
- About 1 ton of Ecomelt from Passaic River sediment was dried and ground to cement fineness (<50 µm) by CTLGroup. It has been shipped to Montclair State University for the beneficial use project.

There are areas of additional cement-related testing that would enhance the Cement-Lock Technology:

- Tests to evaluate the long-term endurance properties of concrete made with Ecomelt should be conducted (will be done by MSU under the Earth and Environmental Studies Department).
- Tests to determine the compressive strength of Ecomelt made outside the "target" composition (within the patent scope) should be conducted.
- Specific large-scale tests should be conducted with feedstock previously tested only as surrogates, i.e., PCB-contaminated soils or sediment.

APPENDIX A.
CTLGROUP REPORTS

TESTING AND EVALUATION OF ECOMELT (May 5, 2007)

EVALUATION OF ECOMELT IN CONCRETE TESTING (May 2008)

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May 5, 2007

Ken Partymiller
TetraTech EM Inc.
5326 Paris Pike
Georgetown, KY 40324

Testing and Evaluation of Ecomelt

Dear Ken:

The report on the Testing and Evaluation of Ecomelt from TetraTech EM Inc. is enclosed. If you have any questions regarding this report, please don't hesitate to contact me.

CTLGroup appreciates the opportunity to work with you on this project, and trusts that we will find additional opportunities to work together.

Sincerely:

Javed Bhatty, Ph.D
Senior Scientist, Material Science and Consulting
Tel: 847 972 3082, Fax (847) 965 6541
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TESTING AND EVALUATION OF ECOMELT

Javed I. Bhatty[1]

SUMMARY

A sample of Ecomelt generated from Passaic River sediment at the Cement-Lock demonstration plant in Bayonne, NJ was received from Tetra Tech EMI (Tetra Tech) for evaluation as a pozzolan for use in cement blends. The as-received material was tested for its physical, chemical, microscopical, and mineralogical properties. Subsequently, the Ecomelt was finely ground and made into a 40:60 Ecomelt:cement blend to test for its engineering properties. The 40:60 Ecomelt:cement blend was evaluated in accordance with ASTM C 1157 and ASTM C 595 specifications for blended hydraulic cements. The material was evaluated as 1) Type GU, hydraulic cement for general construction, and 2) Type HE, high early strength – both under Designation ASTM C 1157, "Standard Performance Specification for Hydraulic Cement." The 40:60 Ecomelt:cement blend was also evaluated as 1) Type S, slag cement, 2) Type I(SM), slag-modified Portland cement, and 3) Type IP, Portland-pozzolan cements – all under Designation: ASTM C 595, "Standard Specification for Blended Hydraulic Cements."

Based on the preliminary data from chemical and physical testing, the Ecomelt appears to exhibit pozzolanic activity. Mortars made with a 40:60 blend of Ecomelt and portland cement complied with the performance requirements of both Type GU and Type HE hydraulic cements – which, according to ASTM C 1157 specifications, are designated as hydraulic cements for general construction and high early strength hydraulic cement, respectively.

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INTRODUCTION

Two 5-gallon buckets of Ecomelt were received from Tetra Tech EMI for evaluation. After the characterization of the Ecomelt, the material was finely ground and a 40:60 blend of the Ecomelt and portland cement was produced for further testing. The following tests were conducted on the as-received Ecomelt as well as on the 40:60 Ecomelt:portland cement blend.

CHARACTERIZATION OF ECOMELT

The as-received Ecomelt sample was a granular mixture of fine, coarse, and flaky fractions as shown in (Figure 1).

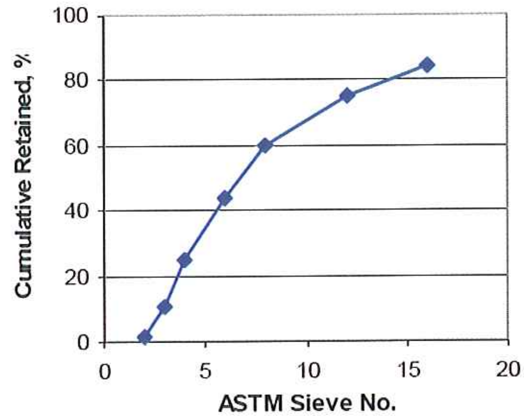
Figure 1. As-received Ecomelt is a mixture of fine, coarse, and flaky fractions

Physical Characterization

Moisture Content - ASTM C 311: The as-received Ecomelt was placed in an oven at 105 to 110°C to dry the material to a constant weight in order to determine moisture content. The weight loss was recorded and the moisture content was determined to be 3.54 weight percent (wt. %).

Particle Size Analysis - ASTM C 136: The dried as-received Ecomelt sample was screened through a set of ASTM standard sieves to determine particle size distribution. Sieving was continued for sufficient time so that not more than 1% of the residue on the sieve passed during one minute of continuous sieving. The fractions retained on sieves and the distribution of particle size is shown in Figure 2a, b, and Table 1.

a)



b)

Figure 2. a) Size fractions and b) size distribution of as-received dried Ecomelt

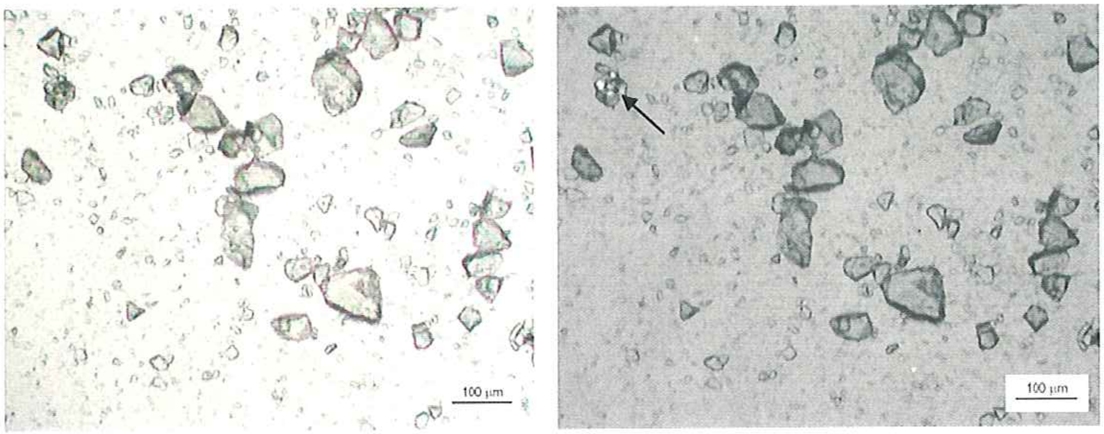
Table 1. Particle size distribution of as-received Ecomelt

ASTM Sieve No.	Sieve Size, microns	Amount Retained, g	Cumulative Retained, g	Cumulative, %
+ ½ "	12500	35	35	1.3
- ½ + ¼"	6300	258	293	10.6
- ¼" + 4	4750	392	685	24.8
- 4 + 6	3350	527	1212	43.8
- 6 + 8	2360	442	1654	59.8
- 8 +12	1700	425	2079	75.2
- 12 + 16	1180	250	2329	84.3
Passing 16	Passing 1180	435	2764	100.0
Total		2764	–	–

The median particle size of the as-received Ecomelt is between sieve No. 6 and 8; i.e. close to 3000 microns (3 mm).

Density Determination - ASTM C128: A representative sample of the as-received dried Ecomelt was tested for density in accordance with the ASTM C 128 procedure. The density was determined to be 2.67 g/cm^3.

Microscopical Examination: A ground sample of the as-received dried Ecomelt was subjected to microscopical examination using ordinary as well as cross-polarized transmission light in order to determine the glassy phase. The examination suggested that the material is predominantly glassy (Figure 3a and 3b). In Figure 3b, the glassy portion of the sample appears transparent. The bright speck (arrow) is the crystalline fraction.



a) b)

Figure 3. a) Ecomelt under plane polar light; b) Ecomelt under cross-polar light, small bright speck at the top left corner (arrow) is crystalline fraction, rest is all glassy

X-RAY Diffraction Analysis: A broad hump around the 2Θ angle of 28 (Figure 4) in the XRD pattern, confirms the presence of an abundance of glassy phase in the Ecomelt sample.

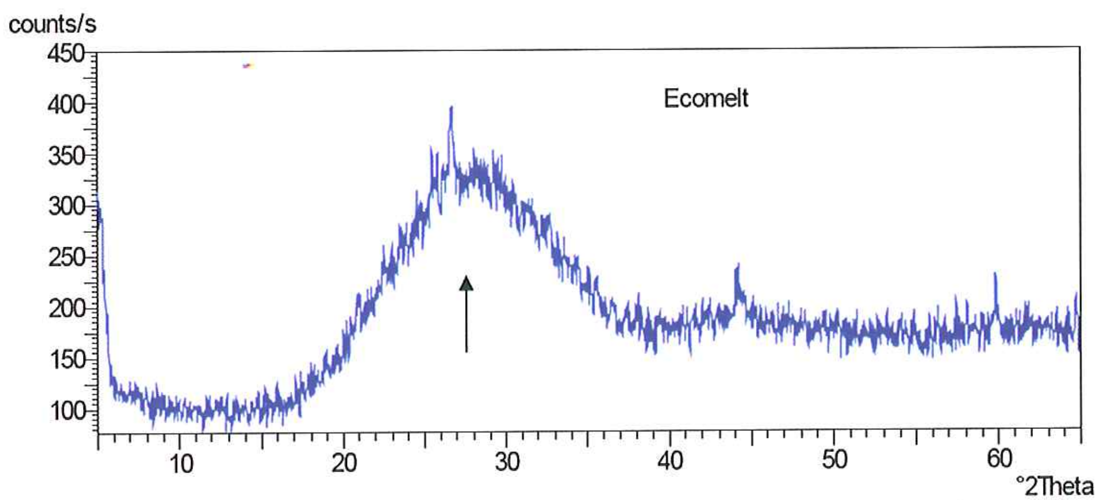


Figure 4. XRD pattern of Ecomelt; hump at the 2Θ angle of 28 confirms glassy phase

Chemical Characterization

Oxide Analysis: A representative sample of the dried Ecomelt was finely ground and analyzed for oxide composition using X-ray fluorescence (XRF) analytical technique. The analysis data are shown in Table 2.

Table 2. Major and minor oxides in Ecomelt

Oxide	Mass, %
SiO_2	52.43
Al_2O_3	16.98
Fe_2O_3	5.41
CaO	18.79
MgO	1.73
SO_3	0.14
Na_2O	1.25
K_2O	1.54
TiO_2	0.67
P_2O_5	0.56
Mn_2O_3	0.11
SrO	<0.01
Cr_2O_3	0.06
ZnO	0.05
L.O.I. (950°C)	– 0.13
$SiO_2 + Al_2O_3 + Fe_2O_3$	74.82
Alkalies as Na_2O equivalent	2.27

Preparation of 40:60 Ecomelt:Cement Blend

Crushing and Grinding of Ecomelt and Fineness Determination: A bulk portion of dried Ecomelt was crushed in a gyratory crusher to pass ASTM No. 6 sieve (Figure 5).

Figure 5. Ecomelt after crushing in a gyratory crusher

The material was then ground in a ball mill until 90% of the material passed the ASTM No. 325 (45μm) sieve. The ground Ecomelt was also tested to determine its Blaine fineness which is a measure of the relative surface area to mass of a sample. The Blaine fineness was 459 m^2/kg. For comparison, Portland cement is typically ground to a Blaine fineness of about 350 m^2/kg. The ground Ecomelt was used in a 40:60 Ecomelt:portland cement blend for the tests outlined in the next section. Samples of ground Ecomelt, 40:60 blend, and portland cement are shown in Figure 6.

Figure 6. (From left) 40:60 Ecomelt:portland cement blend, Ecomelt, and portland cement

TESTING AND EVALUATION OF 40:60 ECOMELT:CEMENT BLEND

Chemical Requirements

Several chemical tests were conducted on the 40:60 Ecomelt:portland cement blend to check for compliance with the ASTM C 595 chemical requirements. These included 1) determination of sulfur as sulfide (S), 2) sulfur as sulfate (SO_3), and 3) insoluble residue. The data and the corresponding standard limits are shown in Table 8.

Table 8. Chemical data on 40:60 Ecomelt:portland cement blend

Tests Conducted	Determined values, %
Sulfur as sulfide (S)	0.030
Sulfur as sulfate (SO_3)	1.65
Insoluble residue	10.03

Physical Testing

Time of Setting - ASTM C 191: The setting time of a neat paste made with 40:60 Ecomelt:portland cement blend was measured by Vicat needle apparatus. The initial time of setting was determined to be 195 minutes, which is well within the minimum and maximum limits of 45 and 420 minutes as allowed by ASTM C 595 and C 1157.

Heat of Hydration - ASTM C 186: The heat of hydration of fresh paste made with the 40:60 Ecomelt:portland cement blend was measured in accordance with the method outlined in ASTM C 186. The heat of hydration values obtained at 7 and 28 days are given in Table 3. The recorded heat of hydration is marginally higher than the ASTM C 595 limit.

Table 3. Heat of hydration of 40:60 Ecomelt:portland cement blend at 7 and 28 days

Test Time	Heat of Hydration, kJ/kg
7-day	293
28-day	408

Compressive Strength - ASTM C 109: Two-inch mortar cubes were prepared with the 40:60 Ecomelt:portland cement blend using a mixing procedure in ASTM C 109. Deionized water was used as the mix water keeping a constant water/cementitious material ratio (w/cm) of 0.484. Mortars cubes were cast in triplicate and left overnight in a moist room at ambient temperature. Thereafter, the cubes were demolded and cured in a moist room maintained at close to 100% relative humidity. Sample cubes before after testing are shown in Figure 7.

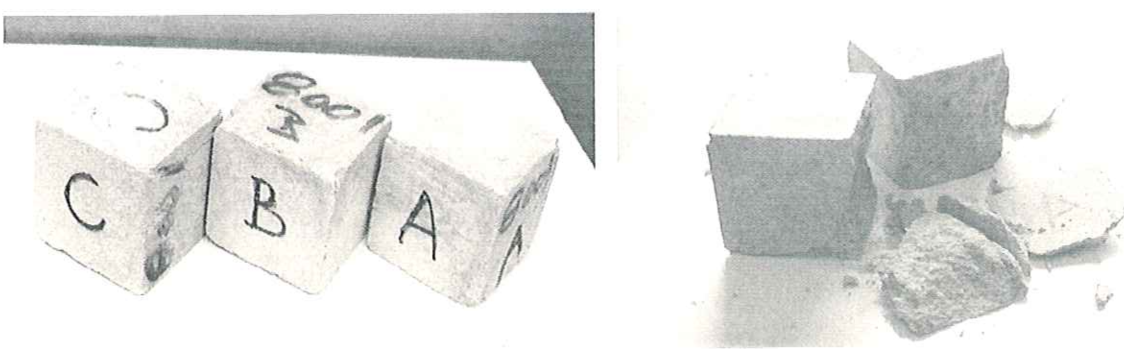


Figure 7. Test cubes before and after compressive strength testing

The cubes were tested for compressive strength after 1, 3, 7, and 28 days. Three cubes were tested at each age and the average value was recorded. Strength comparison of 40:60

Ecomelt:cement mortar was also drawn with mortar made with cement only (control), as shown by data in Table 4.

Table 4. Compressive strength of 40:60 Ecomelt:portland cement blend mortar and comparison with control

Test Periods	Compressive Strength, psi (MPa)				
	40:60 Ecomelt:portland cement mortar				Control mortar, Average
	Sample 1	Sample 2	Sample 3	Average	
1 Day	1803	1753	1843	1800 (12.4)	–
3 Day	3715	3698	3630	3680 (25.4)	3690 (25.5)
7 Day	5300	5233	5353	5300 (36.5)	4860 (33.6)
28 Day	7305	7610	7735	7550 (52.1)	6900 (47.8)

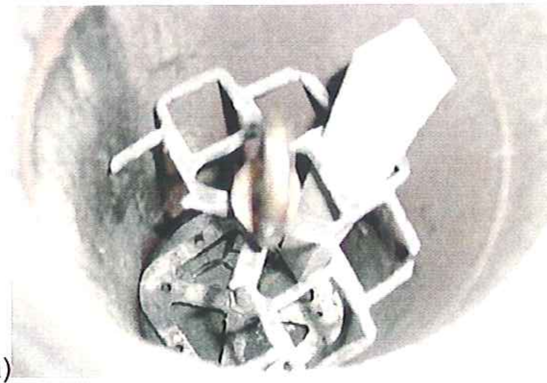
The data indicate that the average strength of mortar made with 40:60 Ecomelt:portland cement exceeded the strengths of the control mortar at 7 and 28 days. Mortars made with 40:60 Ecomelt:cement blend also conformed to both ASTM C 595 and ASTM C 1157 strength requirements. As expected, the compressive strength increased with curing time.

Air Content - ASTM C 185: The air content of fresh mortar made with the 40:60 Ecomelt:portland cement blend was measured in accordance with the procedure outlined in the ASTM C 185. The air content was determined to be 5% by volume (Table 5), which is well within the specified ASTM C 595 maximum limit of 12%.

Table 5. Air content of 40:60 Ecomelt:portland cement blend mortar

Sample tested	Air Content, volume %
40:60 Ecomelt:cement blend	5

Autoclave Expansion/Contraction - ASTM C 151: A test mortar bar was prepared with 40:60 Ecomelt:portland cement blend and tested according to ASTM C 151 method. The results were compared with a mortar bar made with portland cement (control). The mortars were cast as 1 x 1 x 10-inch bars and cured overnight. The bars were demolded, measured for length using a comparator and then placed in the autoclave (high pressure steam vessel) at a saturated steam pressure of 295 ± 10 psig (nominal temperature of 420°F) for 3 hours (Figure 8a). Thereafter, the bars were taken out of the autoclave (Figure 8b), cooled, and measured for any length change. The percent increase/decrease in length to the nearest 0.01% is reported as autoclave expansion/contraction. The results are shown in Table 6:

a) 

b) 

Figure 8 (a, b). Ecomelt:portland cement mortar bar in autoclave expansion test

Table 6. Autoclave expansion/contraction data on 40:60 Ecomelt:portland cement mortars

Sample tested	**Expansion/contraction, %**
40:60 Ecomelt: cement blend	– 0.047

There was no significant expansion or contraction of mortar bars made with the Ecomelt:portland cement blends. This is a favorable result of using a pozzolanic material.

Mortar Expansion (ASR) - ASTM C 227: Test mortar bars were prepared with 40:60 Ecomelt:portland cement blend as 1 x 1x 10-inch bars and cured overnight. The bars were demolded, measured for length, and then placed in a sealed container at 100°F. The bars were measured for length change after withdrawing from the container when 14 days old. Any change to the nearest 0.01% is reported. Test data is shown in Table 7.

Table 7. Mortar expansion (ASR) data on Ecomelt:portland cement mortars

Sample tested	**Expansion, %**
40:60 Ecomelt: cement blend	– 0.003

Again, there was no expansion in the mortar bars made with the Ecomelt:portland cement blends. Instead a contraction of 0.003% was noted. This suggests that the Ecomelt has a negligible tendency for ASR reactivity. ASR – the alkali-silica reaction – is expansive in nature, and occurs between the alkali in the pores of the concrete and reactive silica in some aggregates. Expansion caused by ASR can result in cracking of concrete.

A summary of the overall test results on the 40:60 Ecomelt:portland cement blend and its comparison with both ASTM C 595 and ASTM C 1157 requirements are shown in Table 9.

Table 9. Overall summary of 40:60 Ecomelt:cement blend data and ASTM requirements

Standard Tests Conducted	ASTM Requirements					Test Data	Comment
	ASTM C 595			ASTM C 1157			
	I(SM)	IP	S	GU	HE		
Chemical Tests							
Magnesium Oxide (MgO), max %	*–	6.0	–	–	–	1.73	#meets
Sulfur reported as SO_3, max %	3.0	4.0	4.0	–	–	1.65	meets
Sulfide Sulfur (S), max %	2.0	–	2.0	–	–	0.03	meets
Insoluble residue, max %	1.0	–	1.0	–	–	10.03	does not meet
Loss on ignition, max %	3.0	5.0	4.0	–	–	– 0.13	meets
Physical Tests							
Air content of mortar, max vol., %	12	12	12	–	–	5	meets
Autoclave expansion, max, % Autoclave contraction, max, %	0.80 0.20	0.80 0.20	0.80 0.20	0.80 –	0.80 –	– 0.047	meets
Heat of hydration 7 days, max kJ/kg 28 days, max kJ/kg	 290 330	 290 330	 – –	 – –	 – –	 294 408	does not meet
Initial time of set, min, minutes Initial time of set, max, minutes	45 420	45 420	45 420	45 420	45 420	195	meets
Strength, compression, min, psi 1 day 3 days 7 days 28 days	 – 1890 2900 3620	 – 1890 2900 3620	 – – 720 1600	 – 1450 2465 4060	 1450 2465 – –	 1800 3680 5300 7550	 meets meets meets meets
ASR Expansion,14 days, max %	0.02	0.02	0.02	0.02	0.02	– 0.003	meets

*– No specifications prescribed; #Meets required ASTM requirements

It is evident from the above data and comparison with the standard specifications, that the 40:60 Ecomelt:portland cement blend conforms to both Type GU and Type HE hydraulic cements designated by ASTM C 1157 performance specification. Type GU is designated as hydraulic cement for general construction, whereas Type HE is designated as high early strength hydraulic cement.

Except for heat of hydration and insoluble residue – for which the Ecomelt:portland cement blend exceeded the maximum limits – the 40:60 Ecomelt:portland cement blend conforms to Type I(SM) and Type IP hydraulic cement requirements as designated by ASTM C 595 specification.

CONCLUSIONS AND RECOMMENDATIONS

The mineralogical and microscopical examinations suggest that the Ecomelt is pozzolanic in nature. A blend of 40:60 Ecomelt:portland cement and mortars prepared with it complied with the requirements of Type GU and Type HE cements designated in ASTM C 1157 performance specification. The Ecomelt appears to be potentially suitable as a 40% replacement for portland cement in concrete for use in general construction and/or where high early strength is required. However, CTLGroup recommends that additional testing such as effects on durability including frost resistance, freeze-thaw, scaling, admixture compatibility be conducted on a larger batch of Ecomelt so that an appropriate concrete mix design can be developed for a specific application.

Gas Technology Institute

Project Number 054557

Evaluation of Ecomelt in Concrete Testing

Date:
May 1, 2008

Submitted by:
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EVALUATION OF ECOMELT IN CONCRETE TESTING

by

Javed I. Bhatty[1]

SUMMARY

A sample of Ecomelt was received from Gas Technology Institute for evaluation as partial replacement for portland cement in producing concrete for construction purposes. The material was finely ground so that more than 95% passed the # 325 sieve size. Concrete specimens were fabricated using a blend of 40% ground Ecomelt and 60% Type I/II portland cement. Concrete was tested for a number of ASTM standard test methods that included: ASTM C 403 setting time, ASTM C 39 compressive strength, ASTM C 78 flexural strength, air-content, ASTM C 157 drying shrinkage, ASTM C 666 freeze-thaw resistance, ASTM C 672 deicing-scaling, and ASTM C 1202 resistance to chloride permeability. The results were compared with control concrete samples made under identical conditions but using portland cement only. The objective of these tasks was to determine if the ground Ecomelt could be used as a partial cement supplement in concrete without impacting typical engineering properties.

The data indicate that 40% replacement of cement by ground Ecomelt could produce concrete with properties comparable to those of the control concrete. The setting times for portland blend were slightly longer and the initial strengths were lower. The 56-days compressive and flexural strengths were, however, comparable with those of the control. The results of drying shrinkage and freeze-thaw resistance tests were also comparable to those of the control. Resistance to chloride permeability was noticeably better for the Ecomelt/portland concrete specimen as compared to the control. However, concrete made with Ecomelt displayed more deterioration compared to the control when subjected to the deicer salt-scaling tests.

INTRODUCTION

This report consists of results obtained from the testing and evaluation of a sample of Ecomelt submitted to CTLGroup by Gas Technology Institute (GTI). The Ecomelt was produced from a sediment dredged from the Passaic River during a commercial-scale demonstration of the Cement-Lock® Technology. The Cement-Lock® Technology employs pyro-processing of

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carefully proportioned blends of sediment with other ingredients to immobilize inorganic contaminants in the sediment while producing a marketable product usable in construction applications. Furthermore, the organic compounds in the sediments are reportedly destroyed and converted to innocuous carbon dioxide and water during the pyro-processing of the material (Rehmat et al, 1998).

ECOMELT GRINDING

The as-received Ecomelt sample was dry, free-flowing granular material. It contained coarse granules with presence of larger size glassy aggregates (Figure 1).

Figure 1 The As-Received Ecomelt Sample

The material was first crushed in a jaw crusher into a coarse-grained material followed by secondary crushing in a gyratory crusher to produce a feed for finish grinding (Figure 2).

Figure 2 The Crushed Ecomelt as Feed for Finish Grinding

Forty pounds (40 lbs) of the material was loaded into a ball mill for finish grinding. During the finish grinding process, the Ecomelt was repeatedly checked for its particle size until 95% passed the # 325 sieve. The ground material was stored in sealed bags for later testing in concrete.

BATCHING OF CONCRETE AND SPECIMEN PREPARATION

Concrete Mix Design: The ground Ecomelt was used as 40% by weight replacement of Type I/II portland cement. The mix designs used in the study are given in Table 1.

Table 1 Mix Design for Concrete Batching

Mixes	Control	Test
Type I Cement (%)	100	60
Ecomelt (%)	0	40
Surface Saturated Dry (SSD) Mix Design		
Cement, Continental (lbs.)	564	338.4
Ecomelt (lbs.)	0	225.6
1" Coarse Aggregate, Vulcan (lbs.)	1875	1875
Fine Agg., McHenry Sand (lbs.)	1256	1222
Water, City (lbs.)	255	255
Air entraining agent (AEA), Daravair (oz/cwt.)	1.00	2.25
Water reducer (WR), WRDA 64 (oz/cwt.)	4.25	5.00
Fresh Properties		
Fresh Density (pcf)	145.4	145.4
Slump (in.)	4.00	4.00
Air Content (%)	6.2	5.7
Yield (cf/cy)	27.2	26.9
w/cm ratio	0.45	0.45
Time of Set (hr:min):		
Initial	6:21	6:33
Final	7:37	8:19

The w/cm (water to cementitious material ratio) for both the control and test mix was 0.45. Their slumps (4 in. vs. 4 in.), fresh density (145.4 pcf vs. 145.4 pcf), air contents (6.2% for control vs. 5.7% for test mix), and yields (27.2 cf/cy for control vs. 26.9 cf/cy for test mix), were also kept close to each other by adjusting the addition of air entraining (AEA, Daravair) and water reducing (WRDA 64) admixtures; data on these parameters are also given in Table 1.

The ingredients used in concrete and batch preparation are shown in Figures 3 and 4.

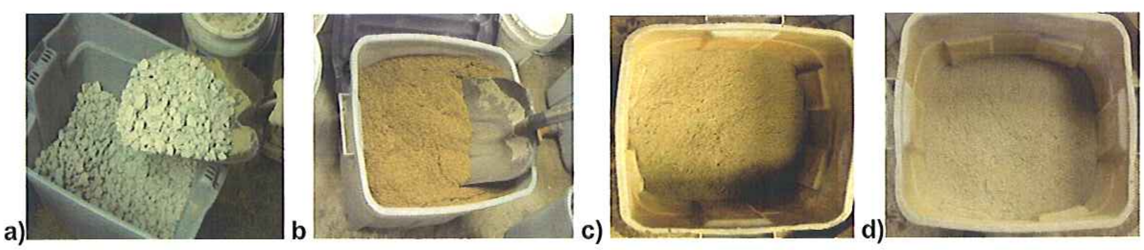

Figure 3 Ingredients Used in Making Concrete a) Coarse Aggregate, b) Fine Aggregate, c) Portland Cement, d) Ecomelt

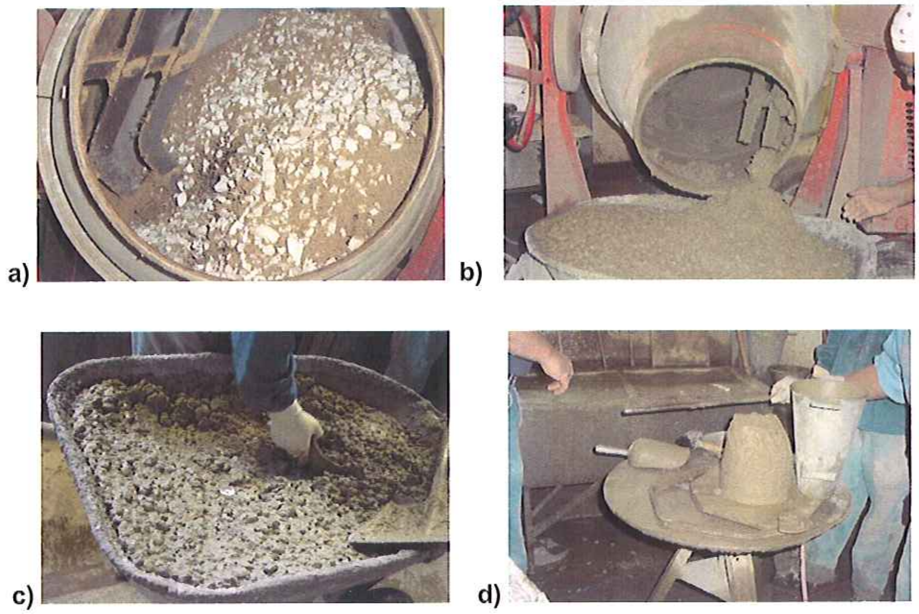

Figure 4 Concrete Batch Preparation

The concrete test specimens were prepared as per the specifications for the respective ASTM standard tests. The specimens were prepared for 1) compressive strength, 2) flexural strength, 3) deicer salt scaling, 4) drying shrinkage, 5) freeze-thaw testing, and 6) chloride-permeability (see Figure 5).

Figure 5 Concrete Specimen Preparation

TESTING AND EVALUATION

The fresh batch was used for making concrete specimens that were tested in accordance with the ASTM standard procedures as follows (Table 2):

Table 2 ASTM Tests Conducted on Concrete Specimens

Test	ASTM Designation	Test Specimen	Curing Regimens
Initial and Final Setting Times	**ASTM C 403/C 403M – 05**: Standard Test Method for Time of setting of concrete Mixtures by Penetration Resistance	Mortar fraction removed from fresh concrete by sieving over No. 4 sieve	Tested by penetration until reaching initial and final setting stages
Compressive Strength	**ASTM C 39/C 39M – 04a**: Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens	4 in. D x 8 in. L cylinders	Cured in 100% relative humidity (RH) until tested at 3*, 7, 28, and 56 days
Flexural Strength	**ASTM C 78 – 02**: Standard Test Method for Flexural Strength of (Using Simple Beam with Third – Point Loading)	3 in. x 3 in. x 11.25 in. prisms	Cured in 100% RH until tested at 3*, 7, and 28 days
Drying Shrinkage	**ASTM C 157M – 04**: Standard Test Method for Length Change of Hardened-Cement Mortars and Concrete	3 in. x 3 in. x 11.25 in. prisms cured at 100% RH in lime saturated water for 28 days then tested for drying shrinkage at 4, 7,14, and 28 days	Change in specimen length monitored
Freeze – Thaw Resistance	**ASTM C 666/C 666M – 03**: Standard Test Method for Resistance of Concrete to Rapid Freezing and Thawing	3 in. x 3 in. x 11.25 in. prisms cured at 100% RH for 14 days, then subjected to freezing/thawing for 301 cycles	Mass change (deterioration) in specimen monitored
Deicer – Scaling Resistance	**ASTM C 672/C 672M – 03**: Standard Test Method for Scaling Resistance of Concrete Surface Exposed to Deicing Chemicals	3 in x 12 in x 12 in. slabs cured at 100% RH for 14 days then at 45-55% RH for 14 days then exposed to deicing chemical for 50 cycles	Deicing salt 4% $CaCl_2$ used for testing, surface scaling (mass deterioration)) in specimen monitored
Rapid Chloride Permeability	**ASTM C 1202 – 97**: Standard Test Method for Electrical Indication of Concrete's Ability to Resist Chloride Ion Penetration	6 in. D x 12 in. L cylinders cured at 100% RH for 56 days and exposed to chloride ions	Charge (Coulombs) measure across the specimen - as a function of permeability

*4-day strength were reported instead as 3-day fell on weekends

The tests results are given in Tables 3 through 12, and Figures 6 through 15.

INITIAL AND FINAL SETTING TIMES (ASTM C 403/C 403M – 05)

Table 3 Setting Time of Concrete Mixes (Hrs:min)

Time of Set	Control Mix	Test Mix
Initial	6:21	6:33
Final	7:37	8:19
Difference	1:16	1:46

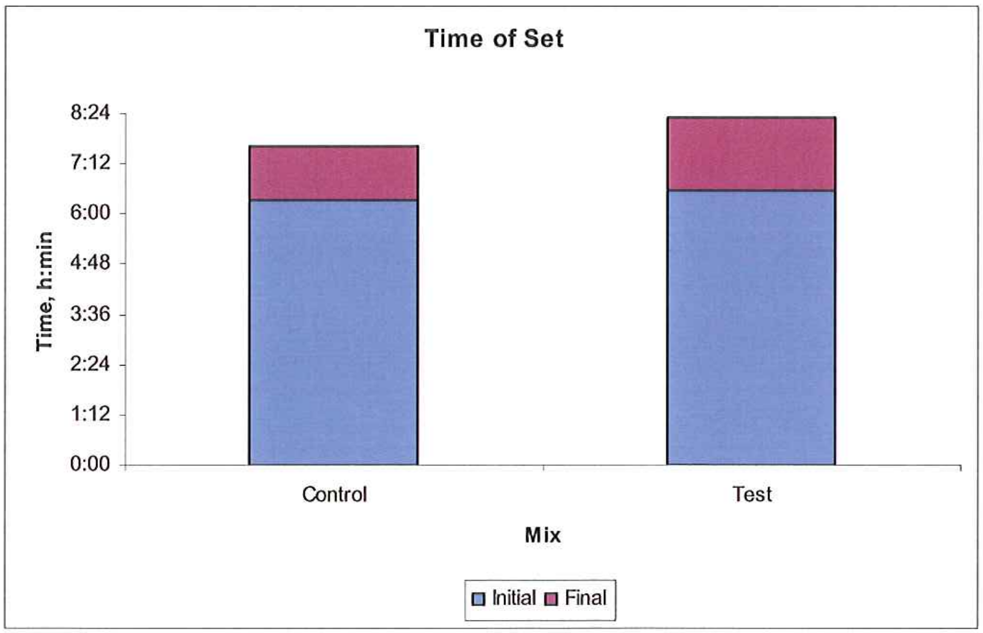

Figure 6 Initial and Final Times of Setting on Test Specimen and Control

COMPRESSIVE STRENGTH (ASTM C 39/C 39M – 04a)

Table 4 Compressive Strength (psi) of Test Specimens Compared with Control

Compressive Strength, 4"x8" Cylinders (psi) Ave. of 3 Specimens Each Age		
Test Age	**Control Mix**	**Test Mix**
4 Days*	4500	2850
7 Days	4800	3450
28 Days	5950	5700
56 Days	6650	6650

* 3rd day fell on a weekend

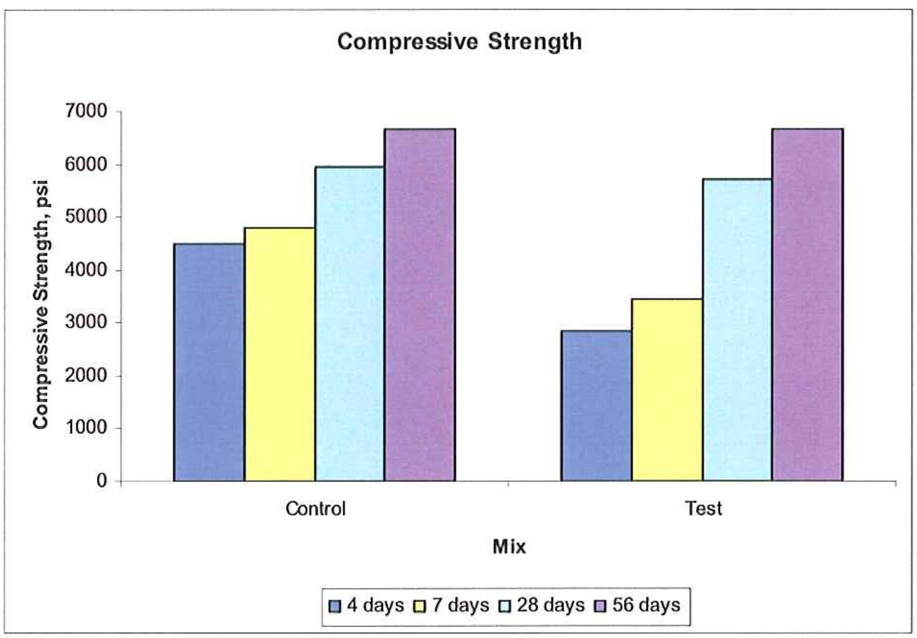

Figure 7 Compressive Strength (psi) of Test Specimen Compared with Control

FLEXURAL STRENGTH (ASTM C 78 – 02)

Table 5 Flexural Strength (psi) of Test Specimens Compared with Control

Flexural Strength, 4"x8" Cylinders (psi) Ave. of 3 Specimens Each Age		
Test Age	**Control Mix**	**Test Mix**
4 Days	690	510
7 Days	740	660
28 Days	920	910

DRYING SHRINKAGE (ASTM C 157M – 04)

Table 6 Drying Shrinkage

Length Change, %, Test Mix					
		Specimens			
Age, days	**Condition**	**A**	**B**	**C**	**Average**
1	*	0.000	0.000	0.000	0.000
28	**	0.004	0.004	0.002	0.003
31	dry***	-0.009	-0.011	-0.014	-0.013
34	dry	-0.013	-0.014	-0.017	-0.016
41	dry	-0.020	-0.020	-0.022	-0.021
55	dry	-0.030	-0.029	-0.032	-0.031

* Specimens demolded and initial measurement taken.

** Specimens stored at 73.4±3° F and immersed in lime-saturated water for 28 days, including the period in the molds.

*** Specimens tested in dry condition at room temperature.

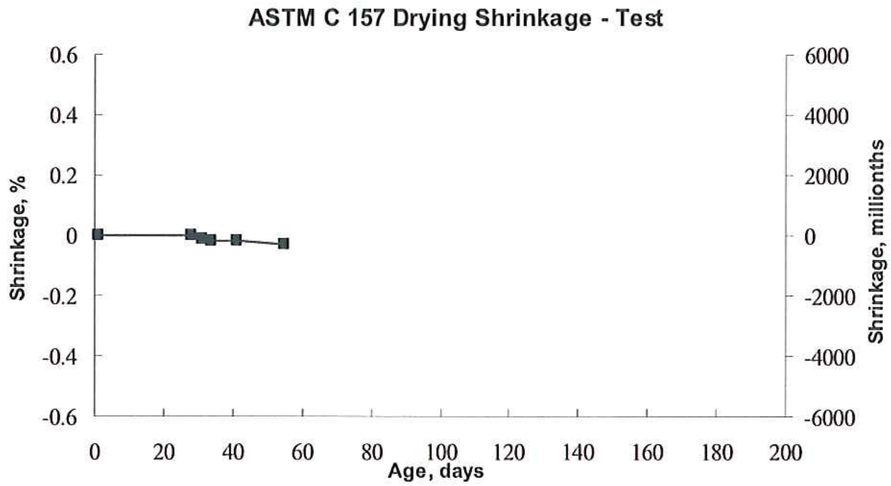

Figure 8 Length Change (%) of Test Specimens

Table 7 Drying Shrinkage

Length Change, %, Control Mix					
		Specimens			
Age, days	**Condition**	**A**	**B**	**C**	**Average**
1	*	0.000	0.000	0.000	0.000
28	**	0.005	0.002	0.002	0.002
32	dry***	-0.016	-0.016	-0.019	-0.017
35	dry	-0.019	-0.020	-0.022	-0.021
42	dry	-0.027	-0.027	-0.029	-0.028
56	dry	-0.037	-0.036	-0.039	-0.038

* Specimens demolded and initial measurement taken.

** Specimens stored at 73.4±3° F and immersed in lime-saturated water for 28 days, including the period in the molds.

*** Specimens tested in dry condition at room temperature.

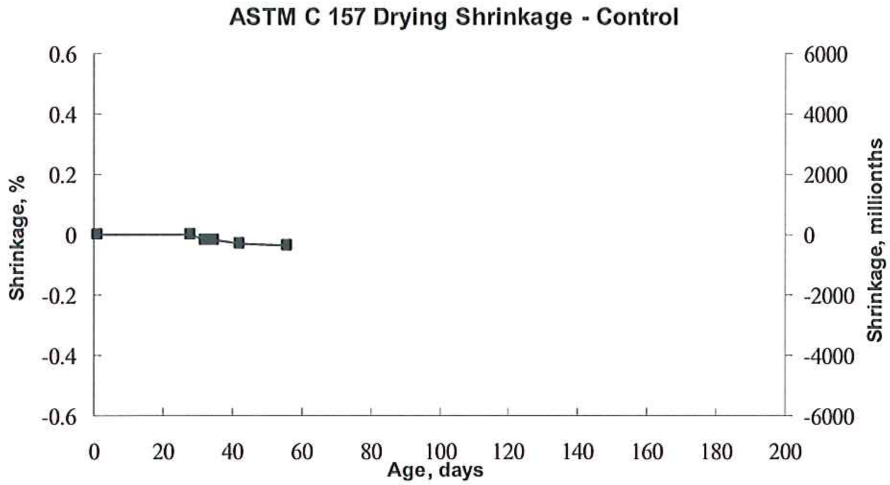

Figure 9 Length Change (%) of Control

FREEZING-THAWING (ASTM C 666)

Table 8 Freezing and Thawing (%) of Test Specimens

Test Results* of ASTM C 666 - Procedure A Freezing and Thawing in Water of Concrete Specimens Test Mix			
	Length	Mass	
Cycles	change, %	change, %	**RDM (1), %
0	0.000	0.00	100
33	0.000	- 0.16	91
65	0.001	- 0.62	91
98	0.000	- 0.55	91
132	0.000	- 1.32	90
162	0.000	- 1.42	90
201	0.000	- 2.10	89
245	0.000	- 2.52	89
288	0.000	- 3.10	89
301	0.000	- 3.27	91

* Values are an average of three specimens.
** RDM = Relative Dynamic Modulus
(1) Severe scaling observed for all specimens.

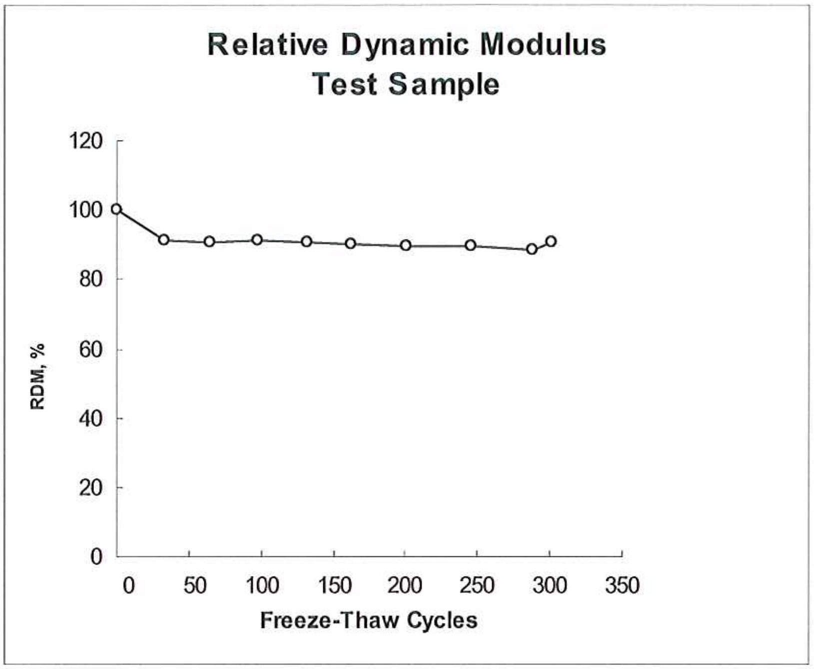

Figure 10 Freezing and Thawing (%) of Test Specimens

Table 9 Freezing and Thawing (%) of Control

Test Results* of ASTM C 666 - Procedure A Freezing and Thawing in Water of Concrete Specimens Control Mix			
	Length	Mass	
Cycles	change, %	change, %	**RDM[(1)], %
0	0.000	0.00	100
33	0.000	- 0.07	95
65	0.001	- 0.21	93
98	0.000	- 0.18	90
132	0.000	- 0.90	93
162	0.000	- 1.25	92
201	0.000	- 1.90	90
245	0.000	- 2.68	90
288	0.000	- 3.23	90
301	0.000	- 3.33	90

* Values are an average of three specimens.
** RDM = Relative Dynamic Modulus
(1) Severe scaling observed for all specimens.

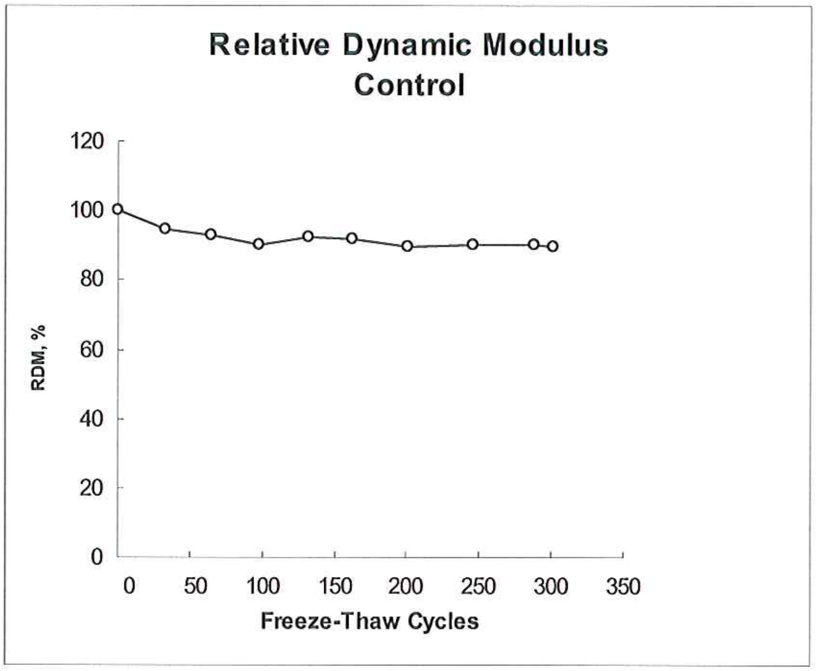

Figure 11 Freezing and Thawing (%) of Control

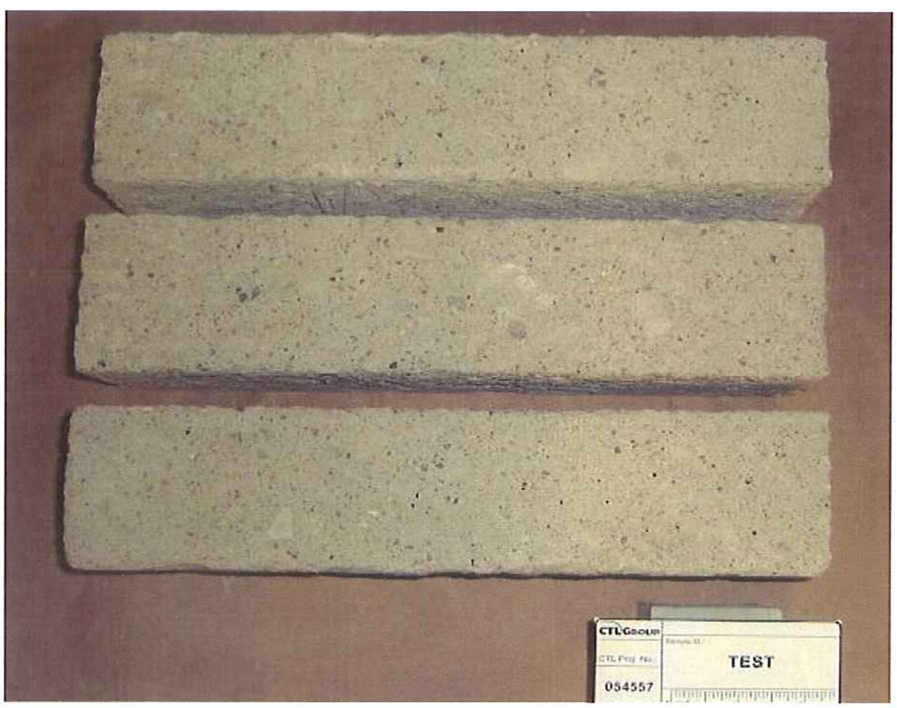

Figure 12a Freezing and Thawing (%) of Test Specimens

Figure 12b Freezing and Thawing (%) of Control Specimens

DEICER-SCALING RESISTANCE (ASTM C 672)

Table 10 Scaling Resistance of Test Specimen Surface Exposed to *Deicing Chemical

	Cumulative Mass Loss, lb/ft^2				Visual Scale Rating (ASTM C 672)**			
Cycle	**1**	**2**	**3**	**Avg.**	**1**	**2**	**3**	**Avg.**
5	0.01	0.01	0.01	0.01	0.5	0.5	0.5	0.5
10	0.01	0.01	0.01	0.01	0.5	0.5	0.5	0.5
15	0.01	0.01	0.01	0.01	ND***	ND	ND	ND
20	0.27	0.31	0.22	0.26	3.5	3.5	3.0	3.3
25	0.27	0.31	0.22	0.27	3.5	3.5	3.0	3.3
30	0.30	0.37	0.24	0.30	4.0	4.0	3.5	3.8
35	0.31	0.44	0.30	0.35	4.0	4.5	3.5	4.0
40	0.33	0.50	0.33	0.39	4.0	5.0	4.0	4.3
45	0.34	0.51	0.35	0.40	4.5	5.0	4.5	4.7
50	0.34	0.51	0.35	0.40	4.5	5.0	4.5	4.7

*Deicing chemical - 4% calcium chloride.
**Rating/Condition of Surface: 0 - no scaling; 1 - very slight scaling (1/8 in. depth max, no coarse aggregate visible)
2 - slight to moderate scaling; 3 - moderate scaling (some coarse aggregate visible); 4 - moderate to severe scaling; 5 - severe scaling (coarse aggregate visible over entire surface)
***ND: not determined

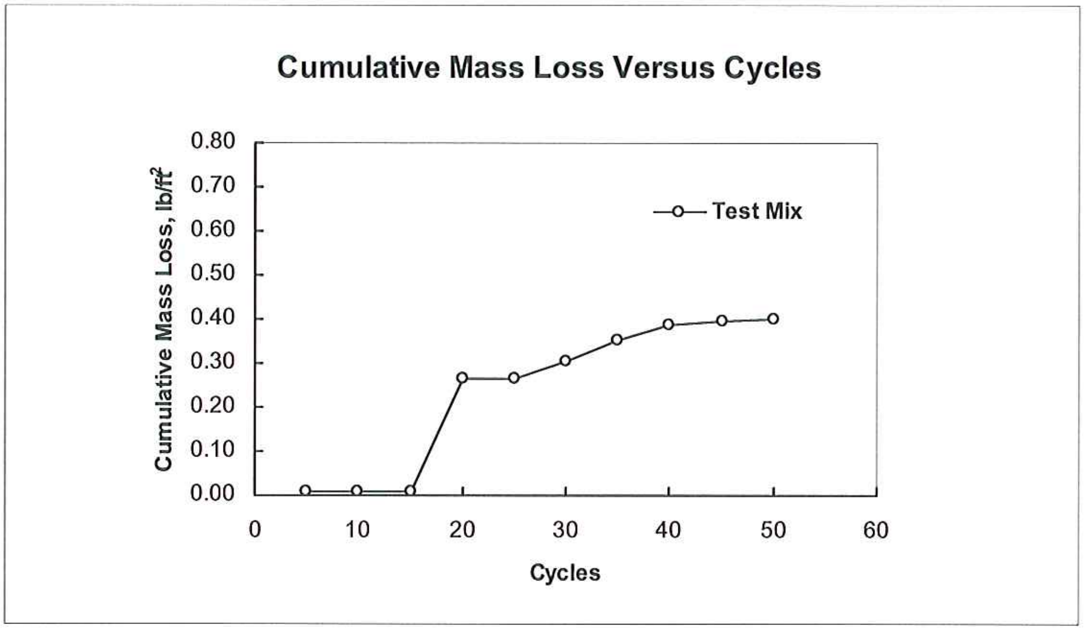

Figure 13 Scaling Resistance of Test Specimen Surface Exposed to Deicing Chemicals

Table 11 Scaling Resistance of Control Surface Exposed to *Deicing Chemical

	Cumulative Mass Loss, lb/ft^2				Visual Scale Rating (ASTM C 672)**			
Cycle	**1**	**2**	**3**	**Avg.**	**1**	**2**	**3**	**Avg.**
5	0.00	0.00	0.00	0.00	0.0	0.0	0.5	0.2
10	0.00	0.00	0.00	0.00	0.0	0.0	0.5	0.2
15	0.00	0.00	0.00	0.00	ND***	ND	ND	ND
20	0.00	0.00	0.01	0.00	0.5	0.5	0.5	0.5
25	0.00	0.00	0.01	0.00	0.5	0.5	0.5	0.5
30	0.02	0.02	0.03	0.02	0.5	0.5	0.5	0.5
35	0.02	0.02	0.03	0.02	0.5	0.5	0.5	0.5
40	0.02	0.02	0.03	0.02	0.5	0.5	0.5	0.5
45	0.02	0.02	0.06	0.03	0.5	0.5	1.0	0.7
50	0.02	0.02	0.07	0.04	0.5	0.5	1.5	0.8

*Deicing solution - 4% calcium chloride.
**Rating / Condition of Surface: 0 - no scaling; 1 - very slight scaling (1/8 in. depth max, no coarse aggregate visible);
2 - slight to moderate scaling; 3 - moderate scaling (some coarse aggregate visible); 4 - moderate to severe scaling; 5 - severe scaling (coarse aggregate visible over entire surface)
***ND: not determined

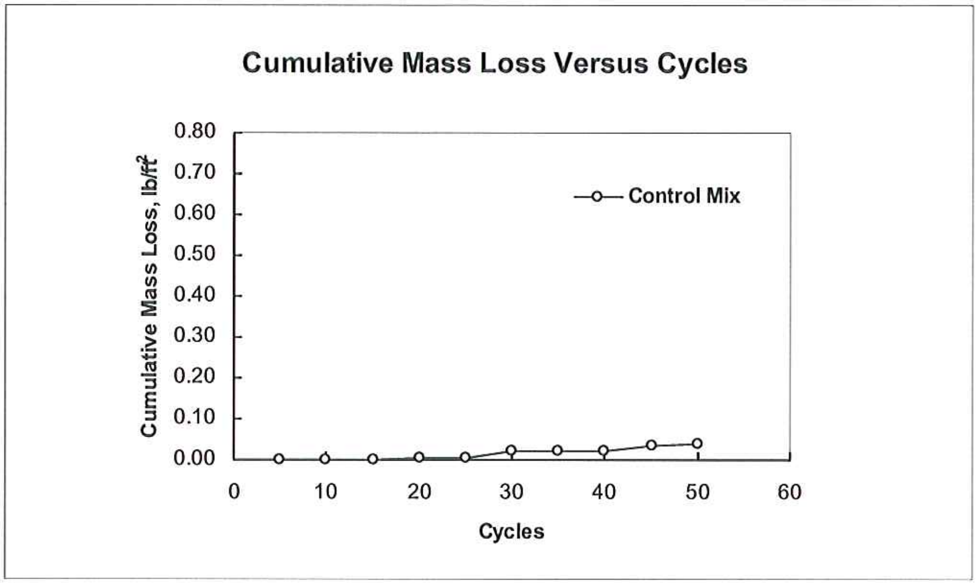

Figure 14 Scaling Resistance of Control Surface to Deicing Chemicals

Figure 15a Scaling Resistance of Concrete Test Specimen to Deicing Chemicals

Figure 15b Scaling Resistance of Control Specimen to Deicing Chemicals

RAPID CHLORIDE PERMEABILITY (ASTM C 1202–97)

Table 12 Modified Rapid Chloride Permeability: ASTM C 1202–97 (AASHTO T 277)*

Sample No.	Charge Passed	Relative
(Sample ID)	**(Coulombs)**	**Chloride Permeability**
# Control - A	3205	Moderate
# Control - B	3207	Moderate
# Control - C	3603	Moderate
# Test Specimen - A	658	Very low
# Test Specimen - B	658	Very low
# Test Specimen - C	653	Very low

Specimen age - 56 days. Specimens were prepared and then moist cured until tested.
*Interpretation of results per ASTM C 1202.

DATA ANALYSIS AND CONCLUSIONS

Test data summarized in Table 13 indicate that, when prepared under identical conditions, concrete made with 40% Ecomelt replacement of portland cement displayed comparable properties to that of the control. An exception seems to be the surface deterioration of the test specimen when exposed to deicing chemicals. However, the chloride permeability of the test specimen is significantly reduced with concrete made with Ecomelt/portland cement blend compared to that of the control.

Table 13 Summary of Data on ASTM Tests Conducted on Concrete Specimens

Tests	**Data for Test Specimen**	**Comparison and Comments**
ASTM C 403/C 403M – 05: Standard Test Method for Time of setting of concrete Mixtures by Penetration Resistance	Both Initial and final setting times longer than the control	Similar to control - Typical for pozzolans as they are slow to react and set but catch up later
ASTM C 39/C 39M – 04a: Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens	Early compressive strength lower than control, but late strength (56-day strength) same	Similar to control - Typical for pozzolans as they exhibit low early strength but catch up later
ASTM C 78 – 02: Standard Test Method for Flexural Strength of (Using Simple Beam with Third – Point Loading)	Early flexural strength lower than control, but late strength (56-day strength) similar	Similar to control - Typical for pozzolans
ASTM C 157M – 04: Standard Test Method for Length Change of Hardened-Cement Mortars and Concrete - Drying Shrinkage	Drying shrinkage over 56-days is similar to control	Similar to control
ASTM C 666/C 666M – 03: Standard Test Method for Resistance of Concrete to Rapid Freezing and Thawing	Freeze-Thaw resistance over 301 cycles is similar to control	Similar to control
ASTM C 672/C 672M – 03: Standard Test Method for Scaling Resistance of Concrete Surface Exposed to Deicing Chemicals	Test specimen showed lower scaling resistance over 50 cycles than control	Worse than control
ASTM C 1202 – 97: Standard Test Method for Electrical Indication of Concrete's Ability to Resist Chloride Ion Penetration	Test specimen showed *very low* permeability compared with *moderate* for control	Better than control

Based on the data obtained with the given mix designs, with the exception of deicing salt-scaling resistance, it appears the 40% replacement of portland cement by ground Ecomelt can produce concrete having comparable properties to those of control concrete made under identical conditions. Slightly longer setting times and lower early strengths indicate the presence of 40% Ecomelt which, like typical pozzolanic materials, is slower to react but gains strength as it ages.

With respect to deicing-scaling resistance, much greater deterioration occurred with the sample containing 40% Ecomelt. This could be due to bleed water accumulated on the surface that reacted with the deicing salt (4% $CaCl_2$ solution). On the other hand the resistance of the test concrete to chloride permeability exceeds that of the control; this could be because the fine Ecomelt particles resulted in a more compact matrix than the control.

One approach could be to conduct concrete testing using lower replacement of portland cement with Ecomelt (for example 25% instead of 40%) - with the anticipation that the scaling performance of concrete could further improve.

REFERENCE CITED

Rehmat, A.; Lee, A.; Goyal, A.; Mensinger, M.; and Bhatty, J. I., "Production of Construction-Grade Cement from Wastes Using Cement-Lock™ Technology," *Proceeding of the 4th Beijing International Symposium on Cement and Concrete*, Beijing, China, Vol. 3, pp 75-181, October 27-30, 1998.

APPENDIX B.

ACCEPTABLE USE DETERMINATION FOR BENEFICIAL USE

OF ECOMELT FROM PASSAIC RIVER SEDIMENT

AT MONTCLAIR STATE UNIVERSITY, NEW JERSEY

State of New Jersey
DEPARTMENT OF ENVIRONMENTAL PROTECTION
Site Remediation Program
Office of Dredging and Sediment Technology
P.O. Box 028
Trenton, NJ 08625
(609) 292-1250
FAX (609) 777-1914

JON S. CORZINE
Governor

LISA P. JACKSON
Commissioner

Mr. Michael C. Mensinger
Senior Engineer
EnDesco Clean Harbors, LLC
1700 S. Mount Prospect Road
Des Plaines, IL 60018-1804

April 22, 2008

RE: **MODIFICATION** of Acceptable Use Determination
Source: Lower Passaic River Dredging Pilot Study

Dear Mr. Mensinger:

This letter is forwarded in response to your request, dated December 14, 2007, for a modification of the Acceptable Use Determination (AUD) issued by the Department on September 19, 2007 for the dredged material removed from the Lower Passaic River Dredging Pilot Study. The AUD modification requests authorization to transport approximately 1 ton of Ecomelt to Montclair University. The request was amended on March 31, 2008 via a letter from the Township of Montclair regarding the beneficial use of the dredged material from the pilot study at Montclair University. The AUD application also serves to update the Department on the final disposition of the 295 tons of dredged material or processed dredged material from the demonstration project.

The December 14, 2007 AUD modification requests authorization to transport approximately 1 ton of Ecomelt to Montclair State University. The material is to be used in a demonstration project at the university as a partial replacement for Portland Cement in the manufacture of a 150-foot section of sidewalk at the university. The project and will be under the oversight of Dr. Greg Pope of the Earth and Environmental Studies Department and will include monitoring of any environmental effects of the use of the treated material. Lastly, in a letter, dated March 31, 2008, the university received notice that the Township of Montclair had been advised of the demonstration project, and that the municipality was in support of the project.

The December 14, 2007 AUD application also provided an update on the final disposition of the 295 tons of material which was authorized in the September 19, 2007 AUD to be transported to various placement sites. The approximately 134 tons of dewatered dredged material and Ecomelt was placed at the Prologis Elizabeth Seaport Business Park. The 160 tons of screened an dewatered sediments from the Lower Passaic River Dredge Pilot Study was transported and disposed of at Wayne Disposal Inc. - Site Number 2 Landfill (Hazardous and PCB Waste Landfill) in Belleville, Michigan.

Based on information presented in the AUD modification request, the Department hereby authorizes the transport and placement of the remaining 1 ton of Ecomelt to Montclair University. The results of this project should be incorporated into the report entitled "Sediment Decontamination Program - Cement Lock Technology, Final Report: Phase II Extended duration Test with Sediment from the Passaic River" dated November 2007, and currently undergoing revisions based on comments from the state agencies.

If you have any questions regarding this letter, please feel free to contact me at (609) 292-8838.

Sincerely,

Suzanne U. Dietrick

Suzanne U. Dietrick, Chief
Office of Dredging and Sediment Technology
Site Remediation and Waste Management

C: Scott Douglas, NJDOT, Office of Maritime Resources
Eric Stern, USEPA Region II

ENDESCO CLEAN HARBORS LLC

Transforming Wastes Into Resources

November 14, 2007

Ms. Suzanne Dietrick, Chief
Site Remediation Program
Office of Dredging and Sediment Technology
New Jersey Department of Environmental Protection
P.O. Box 028
Trenton, New Jersey 08625

RE: Acceptable Use Determination –
Ecomelt from Cement-Lock Demonstration Plant
Origin of Dredged Material: Harrison Reach of the Passaic River

Dear Ms. Dietrick:

The purpose of this letter is to request an Acceptable Use Determination for approximately 1 ton of Ecomelt (remediated sediment product from the Cement-Lock technology produced during operation of the Cement-Lock demonstration plant at IMTT, Bayonne, New Jersey. The original feed material was sediment dredged from the Harrison Reach of the Passaic River.

The approximately 1 ton of Ecomelt is in storage at the facilities of CTLGroup (formerly Construction Technology Laboratories) in Skokie, IL.

This request for an AUD includes the following sections: 1) Cement-Lock Demo Plant Operations Summary, 2) Plan for Beneficial Use, 3) Letter to the local municipality with a discussion of plans for beneficial use of Ecomelt at MSU, and 4) Letter of approval from MSU for the beneficial use project, and 5) Analytical information in Support of AUD Request.

Cement-Lock Demo Plant Operations Summary

Passaic River sediment was processed through the Cement-Lock demo plant during campaigns in December 2006 and May 2007. During these campaigns, a total of about 30 tons of Passaic River sediment-modifier mixture was fed to the system. As part of the most recent campaign, we instituted flame management techniques to slow the accumulation of slag in the drop-out box. Slag accumulated in the drop-out box, nevertheless, and the test was terminated.

During both campaigns, Tetra Tech EMI (and their subcontractors) took environmental samples (sediment, Ecomelt, etc.) under the EPA SITE Program. AirNova took stack emission samples (upstream of the activated carbon bed as well as in the stack) during both campaigns. The results of the analytical tests on these samples have been completed and have been incorporated into the project final report.

Per the requirements of the EIPT permit, the Cement-Lock demo plant equipment has been completely removed from the IMTT site. Further, the site has been restored to its pre-lease conditions.

Plan for Beneficial Use

About 1 ton of finely ground Ecomelt will be used as a partial replacement for Portland cement in a batch of concrete for paving a stretch of sidewalk at the Montclair State University (MSU, Montclair).

A letter sent to the Mayor of Montclair is also included in with this request.

A letter of approval from MSU for the project is also included with this request.

Analytical Information in Support of AUD Request

Analysis of the Ecomelt from Passaic River sediment is attached to this AUD request. The files include:

Ecomelt – filename: Ecomelt Analysis.pdf (Note: SEM = Solid Ecomelt)

If you have any questions about the above, or need additional information, please contact me at 847-768-0602 (office), 630-518-2920 (cell), 847-463-0575 (fax), or mike.mensinger@gastechnology.org. Thank you for your consideration of this request for AUD.

Very truly yours,

Michael C. Mensinger

Michael C. Mensinger
Senior Engineer

cc: Scott Douglas, NJ-DOT/OMR
Eric Stern, U.S. EPA Region 2
Keith Jones, BNL
Michael Roberts, ENDESCO Clean Harbors

Township of Montclair 205 Claremont Avenue Montclair, NJ 07042 tel: 973-509-5721 fax: 973-509-9589

Gray Russell
Code Enforcement/Environmental Coordinator
grussell@montclairnjusa.org

Amy V. Ferdinand
Director, Environmental Health and Safety
Montclair State University

March 31, 2008

Dear Ms. Ferdinand,

Thank you for your letter of March 19, explaining the proposed Pilot Demonstration Project at Montclair State University showcasing the beneficial use of sediments from the Passaic River.

The Township of Montclair is committed to sustainable use of materials, including used resources, and we are always interested in learning more from controlled experiments using innovative technologies. I understand that you have applied to the NJ Dept. of Environmental Protection Office of Dredging and Technology for the beneficial use of the dredge materials.

This letter acknowledges my prior conversation with Eric Stern, USEPA Region 2 program lead for the Sediment Decontamination Program, and the phone conversation and letter I received from you, explaining the project.

Because of the opportunity to combine the sediments with the organic material generated from Nicholas J. Smith-Sebasto (EAES, MSU), I would be pleased to be kept informed of the progress MSU achieves, and of any "project meetings, field demonstrations, and post-project monitoring and results of data evaluations as the project develops", as you have indicated.

Unfortunately my schedule with municipal matters reduces my ability to be a more active observer. I hope your project is successful.

If you have any further questions or comments please do not hesitate to contact me anytime, at your convenience.

Sincerely,
Gray

Gray Russell
Environmental Coordinator
Township of Montclair
Department of Administration, Code Enforcement,
and Environmental Affairs
205 Claremont Avenue
Montclair, New Jersey 07042
Tel. #: (973) 509-5721
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Email: grussell@montclairnjusa.org

Montclair State University

Environmental Health and Safety
Voice 973-655-4367
Fax 973-655-7837
E-mail ferdinanda@mail.montclair.edu

March 19, 2008

Mr. Gray Russell, Coordinator
Department of Environmental Affairs
Township of Montclair
205 Claremont Avenue
Montclair, New Jersey 07042

Dear Mr. Russell:

Montclair State University is committed to being at the cutting edge of technological advancements as we seek the best possible educational tools that can benefit not only our gifted students and faculty but the community at large.

Because of Montclair Township's commitment to environmental stewardship and sustainability, we are informing you and the Township of an exciting Pilot Demonstration Study to be established at Montclair State University. The Demonstration will further develop educational and research programs within the MSU academic community in the discipline of Environmental Management (Masters and Doctoral Program). We hope that in the long run, results of the demonstration will improve the quality of the state environment and the quality of life for all its residents.

The proposed project is a pilot demonstration showcasing the beneficial use of sediments from the Passaic River, NJ that have been decontaminated using two innovative sediment treatment technologies. The New York/New Jersey Sediment Decontamination Program has been working since 1993 with partners from the U.S. Environmental Protection Agency Region 2 (USEPA), NJ Department of Transportation Office of Maritime Resources (NJDOT) and the Brookhaven National Laboratory (BNL) in determining the environmental and economic feasibility of decontaminating sediments from the Port of New York & New Jersey. The program focuses on sediments as a resource – not a waste. Technologies developed under this program have progressed from bench-, to pilot-, to full-scale demonstrations. Materials produced from decontaminated sediments include construction-grade cement, bricks, tiles, lightweight aggregate, and manufactured soil.

Phase 1 of the demonstration involves blending (with compost, sand, wood chips etc) and placement of twenty (20) cubic yards of decontaminated Passaic River sediment from the ***Biogenesis Sediment Washing Decontamination Technology.*** The manufactured soil will be used for landscaping purposes as part of the MSU master landscaping plan.

Phase 2 involves pouring of approximately 150 feet of sidewalk that incorporates one (1) ton of post-treated sediment material from the ***Gas Technology Institute thermo-chemical Cement-Lock Process***. Ecomelt, which is essentially a granular black glass (beneficial use component) derived from the treatment process has been finely ground and will be used as a *partial* replacement for Portland cement in the production of a batch of concrete. The mix design for the concrete will be based on an Ecomelt / Portland cement blend consisting of 40% Ecomelt and 60% Portland cement.

An application for Acceptable Use Determination (AUD) has been filed with the NJ Department of Environmental Protection (NJDEP) Office of Dredging and Technology for the beneficial use of these two materials. NJDEP has been an integral part of the technical and regulatory process in evaluating these innovative technologies.

MSU research faculty and graduate students of the Earth and Environmental Studies (EAES) Department will oversee the long-term monitoring and stability of these beneficial use applications. The MSU Division of University Facilities, Office of University Planning, and Office of Environmental Health and Safety are fully aware, support, and are integrated into this on-campus beneficial use demonstration project.

The 20 cubic yards of post-treated sediment prior to soil blending and the one ton of Ecomelt (contained in five 55-gallon sealed drums) prior to being incorporated into the batch of concrete will be stored and handled in an environmentally safe manner.

As per your recent discussion with Eric Stern, USEPA Region 2 program lead for the Sediment Decontamination Program, we would like to request a letter of acknowledgement and acceptance of the demonstration project from you in your capacity as Montclair Environmental Affairs Coordinator. Further, we would like to ask that you participate directly in the project. At a minimum, we would keep you informed of project meetings, field demonstrations, and post-project monitoring and results of data evaluations as the project develops. Your knowledge and reputation in recycling, environmental sustainability and climate change related to waste management would clearly be an asset to this program.

Please let me know if you are willing to provide a letter and your level of interest to participate. If you have any questions or require additional information, I can be reached at (973) 655.4367 or email: ferdinanda@mail.montclair.edu.

Sincerely,

Amy V. Ferdinand

Amy V. Ferdinand
Director, Environmental Health and Safety

Cc: Greg Bressler, VP of University Facilities, MSU
Robert Prezant, Dean – CSAM, MSU
Duke Ophori, Chair – EAES, MSU
Michael Kruge – EAES, MSU
Gregory Pope – EAES, MSU
Nicholas J. Smith-Sebasto – EAES, MSU
Mike Zanko, Director of University Planning, MSU
Michael Mensinger, Gas Technology Institute
John Sontag, BioGenesis Enterprises
Eric Stern, USEPA Region 2

Analytical Results of Ecomelt Samples from Passaic River Sediment – Phase II Cement-Lock Demonstration (Dec 06 and May 07)

Compound	P2-SEM-01	P2-SEM-02	P2-SEM-03	P2-SEM-04	P2-SEM-04 Dup	P2-SEM-05	P2-SEM-06	Average	P3-SEM-01	P3-SEM-02
PCBs	pg/g								pg/g	
1-MoCB	0.499 UJ	0.33 UJ	0.586 U	0.557 U	0.454 U	1.25	0.278 UJ	0.56	0.615 U	0.432 U
2-MoCB	0.463 U	0.324 UJ	0.627 U	0.612 U	0.56 U	2.62	0.724 U	0.85	ND U	1.14 U
3-MoCB	0.402 U	0.297 UJ	0.922 JQ	0.367 UJ	0.652 J	0.432 U	0.25 UJ	0.47	0.894 U	1.28 U
4-DiCB	1.78 U	2.85 U	1.09 U	1.34 U	0.864 U	1.97 U	1.74 U	1.66 U	ND U	ND U
5-DiCB	0.459 U	0.54 U	0.976 U	1.45 U	0.834 U	2 U	2.62 U	1.27 U	ND U	ND U
6-DiCB	0.393 U	0.462 U	0.656 U	0.977 U	0.56 U	2.17 U	2.09 U	1.04 U	1.24 U	ND U
7-DiCB	0.363 U	0.426 U	0.611 U	0.91 U	0.522 U	2.06 U	1.98 U	0.98 U	ND U	ND U
8-DiCB	0.35 U	0.412 U	0.529 U	0.788 U	1.4	2.55 U	1.8 U	1.12	4.39 U	3.18 U
9-DiCB	0.441 UJ	0.518 UJ	0.838 U	-	0.715 U	2.98 U	2.86 U	1.39	ND U	ND U
10-DiCB	1.14 U	1.71 U	0.677 U	0.856 U	0.555 U	1.35 U	2.34 U	1.23	ND U	ND U
11-DiCB	0.424 U	0.498 U	0.748 U	1.11 U	0.639 U	2.52 U	66.1	10.29	16 U	15.3 U
12-DiCB	0.39 U	1.85 J	0.68 U	1.01 U	0.581 U	2.3 U	2.13 U	1.28	1.18 U	ND U
13-DiCB	C12	C12	C12	C12	C12	C12	C12	C12	C12	C12
14-DiCB	0.426 U	0.501 U	0.743 U	1.11 U	0.634 U	2.48 U	2.4 U	1.18	ND U	ND U
15-DiCB	0.504 U	0.573 U	0.769 U	1.16 U	0.669 U	2.54 U	1.28 U	1.07	5.9 U	5.19 U
16-TrCB	0.936 U	0.7 U	0.65 U	0.623 U	0.612 UJ	0.464 U	0.619 U	0.66	3.89 U	2.67 U
17-TrCB	0.907 U	0.678 U	0.778 U	0.746 U	0.733 U	0.547 U	0.803 U	0.74 U	6.74 U	4.56 U
18-TrCB	0.789 U	0.59 U	2.4 C	0.659 U	0.648 U	0.508 U	0.7 U	0.90	12.1 U	7.36 U
19-TrCB	1.13 U	0.895 U	0.821 U	0.826 U	0.759 U	0.58 U	0.476 U	0.78 U	1.88 U	1.06 U
20-TrCB	0.567 U	0.424 U	0.597 U	0.572 U	0.562 U	0.398 U	17.2 C	2.90	23.3 U	18.9 U
21-TrCB	0.549 U	0.41 U	0.559 U	2.76 CJ	2.49 C	0.376 U	0.579 U	1.10	9.43 U	6.35 U
22-TrCB	0.623 U	0.465 U	0.613 U	0.587 U	0.577 U	0.423 U	0.594 U	0.55 U	8.14 U	6.31 U
23-TrCB	0.562 U	0.42 U	0.56 U	0.536 U	0.527 U	0.402 U	0.546 U	0.51 U	ND U	ND U
24-TrCB	0.713 U	0.532 U	0.531 U	0.509 U	0.5 U	0.443 U	0.62 U	0.55 U	ND U	ND U
25-TrCB	0.466 U	0.348 U	0.602 JQ	0.47 UJ	0.462 U	0.308 UJ	1.68	0.62	2.12 U	1.84 U
26-TrCB	0.564 U	0.422 U	0.581 U	0.556 UJ	0.547 U	0.417 U	0.599 U	0.53 U	4.24 U	3.14 U
27-TrCB	0.699 U	0.522 U	0.694 U	0.664 U	0.653 U	0.451 U	0.642 U	0.62 U	1.41 U	1.3 U
28-TrCB	C20	C20	C20	C20	C20	C20	C20	C20	C20	C20
29-TrCB	C26	C26	C26	C26	C26	C20	C20	C20	C26	C26
30-TrCB	C18	C18	C18	C18	C18	C18	C18	C18	C18	C18
31-TrCB	0.595 U	0.444 U	0.606 U	0.58 U	0.57 U	0.427 U	11.5	2.10	17.1 U	13.1 U
32-TrCB	0.613 U	0.458 U	1.12	0.542 U	0.533 UJ	0.418 U	2.44	0.87	5.34 U	3.63 U
33-TrCB	C21	C21	C21	C21	C21	C21	C21	C21	C21	C21
34-TrCB	0.689 U	0.515 U	0.638 U	0.611 U	0.601 U	0.463 U	0.707 U	0.60 U	ND U	ND U
35-TrCB	0.74 U	0.524 U	0.677 U	0.632 U	0.624 U	0.683 U	0.576 U	0.64 U	0.692 U	0.535 U
36-TrCB	0.675 U	0.478 U	0.721 U	0.673 U	0.664 U	0.599 U	0.484 U	0.61 U	ND U	ND U
37-TrCB	0.78 U	0.529 U	0.693 U	0.625 U	0.648 U	0.749 U	0.281 U	0.62 U	6.53 U	6.52 U
38-TrCB	0.737 U	0.521 U	0.642 U	0.6 U	0.591 U	0.71 U	0.561 U	0.62 U	ND U	ND U

Compound	P2-SEM-01		P2-SEM-02		P2-SEM-03		P2-SEM-04		P2-SEM-04 Dup		P2-SEM-05		P2-SEM-06		Average		P3-SEM-01		P3-SEM-02	
39-TrCB	0.645	U	0.456	U	0.563	U	0.525	U	0.518	U	0.59	U	0.457	U	0.54	U	ND	U	ND	U
40-TeCB	14.1	C	11.4	C	1.09	U	1.22	CJ	1.23	CJ	0.762	U	0.968	U	4.40		8.21	U	6.3	U
41-TeCB	0.458	U	0.84	U	1.6	U	1.27	U	1.36	U	1.16	U	1.8	U	1.21	U	0.776	U	1.14	U
42-TeCB	9		6.45		1.18	U	0.937	U	1	U	0.899	U	2.76		3.18		4.4	U	3.62	
43-TeCB	1.74		0.776	UJ	1.03	U	0.82	U	0.877	U	0.753	U	0.906	U	0.99		0.451	U	0.237	U
44-TeCB	34.6	C	27.8	C	1.04	U	0.827	U	0.885	UJ	0.773	U	0.974	U	9.56		19.6	U	13	U
45-TeCB	6	C	0.782	U	1.26	U	1.1	U	1.12	U	0.827	U	0.887	U	1.71		6.93	U	3.96	U
46-TeCB	0.713	U	0.827	U	1.28	U	1.12	U	1.14	U	0.843	U	0.881	U	0.97	U	1.31	U	0.857	U
47-TeCB	C44		C44		C44		C44		C44		C44		C44		C44		C44		C44	
48-TeCB	5.69		0.616	U	1.15	U	0.91	U	0.973	U	0.825	U	1.07	U	1.60		3.19	U	2.4	U
49-TeCB	20.8	C	15.9	C	2.05	C	2.28	CJ	1.84	CJ	4.17	C	8.28	C	7.90	C	12.4	U	7.95	U
50-TeCB	0.663	U	0.769	U	1.21	U	1.06	U	1.08	U	0.798	U	0.856	U	0.92	U	5.1	U	3.01	U
51-TeCB	C45		C45		C45		C45		C45		C45		C45		C45		C45		C45	
52-TeCB	35.2		0.638	U	1.43	U	1.13	U	1.21	U	0.942	U	22.5		9.01		23.4	U	15.1	U
53-TeCB	C50		C50		C50		C50		C50		C50		C50		C50		C50		C50	
54-TeCB	0.691	UJ	1.02	U	0.766	U	0.7	U	0.706	U	0.397	U	0.243	U	0.65	U	0.444	U	0.173	U
55-TeCB	28.9		0.446	U	1.8	U	0.618	U	0.701	U	0.506	U	1.18	U	4.88		12.6	U	9.91	
56-TeCB	0.569	U	0.43	U	1.46	U	0.503	U	0.916	J	0.432	U	1.01	U	0.76		6.29	U	4.59	U
57-TeCB	0.585	U	0.442	U	1.84	U	0.634	U	0.719	U	0.562	U	1.35	U	0.88	U	ND	U	ND	U
58-TeCB	0.553	UJ	0.418	U	1.76	U	0.605	U	0.686	U	0.519	U	1.23	U	0.82	U	0.462	J	0.54	U
59-TeCB	2.99	J	2.37	CJ	0.894	U	0.71	U	0.759	U	0.688	UJ	0.958	CJ	1.34		1.8	U	1.4	U
60-TeCB	0.543	U	0.411	U	1.61	U	1.18		0.628	U	0.488	UJ	1.13	U	0.86		2.01	U	1.93	U
61-TeCB	0.565	U	0.427	U	5.25	C	4.84	CJ	3.47	CJ	0.487	U	14.6	C	4.23		21.1	U	17.8	U
62-TeCB	C59		C59		C59		C59		C59		C59		C59		C59		C59		C59	
63-TeCB	0.617	U	0.467	U	1.88	U	0.646	U	0.733	U	0.568	U	1.33	U	0.89	U	0.674	U	0.561	U
64-TeCB	13.3		0.468	U	0.86	U	0.682	U	0.73	U	0.595	U	0.798	U	2.49	U	7.61	U	5.69	U
65-TeCB	C44		C44		C44		C44		C44		C44		C44		C44		C44		C44	
66-TeCB	0.57	U	0.431	U	3.08		0.605	U	2.07		0.534	U	8.22		2.22		13.4	U	10.5	U
67-TeCB	1.16		0.952	J	1.46	U	0.502	U	0.57	U	0.431	U	1.02	U	0.87		0.525	U	0.481	U
68-TeCB	0.494	U	0.373	UJ	1.56	U	0.538	U	0.61	U	0.487	U	1.12	U	0.74	U	0.279	U	0.239	U
69-TeCB	C49		C49		C49		C49		C49		C49		C49		C49		C49		C49	
70-TeCB	C61		C61		C61		C61		C61		C61		C61		C61		C61		C61	
71-TeCB	C40		C40		C40		C40		C40		C40		C40		C40		C40		C40	
72-TeCB	0.546	U	0.413	U	1.64	U	0.564	U	0.64	U	0.535	U	1.27	U	0.80	U	0.277	U	ND	U
73-TeCB	0.248	UJ	0.455	U	0.858	U	0.681	U	0.728	U	0.662	U	0.899	U	0.65	U	0.511	J	0.437	U
74-TeCB	C61		C61		C61		C61		C61		C61		C61		C61		C61		C61	
75-TeCB	C59		C59		C59		C59		C59		C59		C59		C59		C59		C59	
76-TeCB	C61		C61		C61		C61		C61		C61		C61		C61		C61		C61	
77-TeCB	2.73		0.392		1.53	U	0.551	U	0.62	U	0.476	U	0.589	U	0.98		2.18	U	1.39	U
78-TeCB	0.561	U	0.424	U	1.75	U	0.603	U	0.684	U	0.499	U	1.24	U	0.82	U	ND	U	ND	U

Compound	P2-SEM-01		P2-SEM-02		P2-SEM-03		P2-SEM-04		P2-SEM-04 Dup		P2-SEM-05		P2-SEM-06		Average		P3-SEM-01		P3-SEM-02	
79-TeCB	0.459	U	0.347	U	1.52	U	0.522	U	0.593	U	0.426	U	1.02	U	0.70	U	ND	U	ND	U
80-TeCB	0.502	U	0.38	U	1.54	U	0.528	U	0.6	U	0.464	U	1.04	U	0.72	U	ND	U	ND	U
81-TeCB	0.518	U	0.38	U	1.77	U	0.569	U	0.651	U	0.483	U	0.576	U	0.71	U	0	U	0	U
82-PeCB	3.82		0.75	U	1.36	U	1.16	U	1.5	U	0.768	U	1.91	U	1.61		2.09	U	1.45	U
83-PeCB	0.652	U	0.906	U	1.61	U	1.38	U	1.78	U	1.08	U	2.94	U	1.48	U	1.1	U	1.17	U
84-PeCB	8.22		0.679	U	1.31	U	1.12	U	1.45	U	0.812	U	4.68		2.61		5.01	U	4.2	U
85-PeCB	0.371	U	4.12	C	1	U	0.856	U	1.11	U	0.576	U	2.46	C	1.50		2.72	U	2.41	
86-PeCB	23	C	0.548	U	1.03	UJ	3.72	CJ	1.13	UJ	0.591	U	14.8	C	6.40		12.8	U	7.73	U
87-PeCB	C86		C86		C86		C86		C86		C86		C86		C86		C86		C86	
88-PeCB	5.62	C	2.01	C	2.11	U	1.8	U	2.33	U	0.773	U	1.87	U	2.36		3.11	U	2.56	U
89-PeCB	0.502	UJ	0.698	U	1.39	U	1.19	U	1.54	U	0.865	U	2.02	U	1.17		0.34	U	0.317	U
90-PeCB	30.3	C	22.2	C	1.11	U	0.948	U	1.23	U	0.642	U	12.6	C	9.86		16.9	U	10.9	U
91-PeCB	C88		C88		C88		C88		C88		C88		C88		C88		C88		C88	
92-PeCB	6.68		4.41		1.31	U	1.12	U	1.44	U	0.77	U	2.73		2.64		3.14	U	2.22	U
93-PeCB	0.467	U	1.97	CJ	1.21	U	1.03	U	1.33	U	0.748	U	1.77	U	1.22		1.03	U	0.887	U
94-PeCB	0.461	UJ	0.641	U	1.25	U	1.07	U	1.38	U	0.788	U	1.82	U	1.06		0.347	U	0.322	U
95-PeCB	0.45	U	18.8		1.27	U	1.08	U	1.4	U	0.808	U	16.2		5.72		14.3	U	11.2	U
96-PeCB	0.483	UJ	0.444	U	1.29	U	1.11	U	1.3	U	1.06	U	1.68	U	1.05	U	0.356	U	0.373	U
97-PeCB	C86		C86		C86		C86		C86		C86		C86		C86		C86		C86	
98-PeCB	2.3	C	1.56	J	1.07	U	0.913	U	1.18	U	0.663	U	1.59	U	1.33		1.21	U	0.911	U
99-PeCB	13.1		8.99		1.41		1.81		1.16	U	0.609	U	5.29		4.62		6.24	U	5.56	U
100-PeCB	C93		C93		C93		C93		C93		C93		C93		C93		C93		C93	
101-PeCB	C90		C90		C90		C90		C90		C90		C90		C90		C90		C90	
102-PeCB	C98		C98		C98		C98		C98		C98		C98		C98		C98		C98	
103-PeCB	0.416	U	0.578	UJ	1.2	U	1.02	U	1.32	U	0.751	U	1.8	U	1.01		0.544	J	0.349	U
104-PeCB	0.344	UJ	0.308	U	0.893	U	0.81	U	0.859	U	0.607	U	0.555	U	0.63		0.178	U	0.17	U
105-PeCB	8.31		7.71		1.28		0.88	U	1.28	U	0.882	U	1.37		3.10		29	U	17.3	U
106-PeCB	0.603	U	0.477	U	0.911	U	0.899	U	1.23	U	0.866	U	0.666	U	0.81		ND	U	ND	U
107-PeCB	1.02	J	0.494	U	0.908	U	0.896	U	1.23	U	0.817	U	0.69	U	0.87		0.624	U	ND	U
108-PeCB	C86		C86		C86		C86		C86		C86		C86		C86		C86		C86	
109-PeCB	2.13		0.482	U	0.926	U	0.914	U	1.25	U	0.808	U	0.669	U	1.03		1.33	U	0.789	U
110-PeCB	33.9	C	25.7	C	0.853	U	0.728	U	0.942	U	0.454	U	1.15	U	9.10		18.5	U	11.7	U
111-PeCB	0.335	U	0.466	U	0.849	U	0.725	U	0.937	U	0.472	U	1.18	U	0.71		ND	U	ND	U
112-PeCB	0.323	U	0.448	UJ	0.876	U	0.748	U	0.967	U	0.48	U	1.23	U	0.72		ND	U	ND	U
113-PeCB	C90		C90		C90		C90		C90		C90		C90		C90		C90		C90	
114-PeCB	0.653	U	0.583	J	0.919	U	0.875	U	1.23	U	0.87	U	0.339	U	0.78		0.28	U	0	U
115-PeCB	C110		C110		C110		C110		C110		C110		C110		C110		C110		C110	
116-PeCB	C85		C85		C85		C85		C85		C85		C85		C85		C85		C85	
117-PeCB	C85		C85		C85		C85		C85		C85		C85		C85		C85		C85	
118-PeCB	22.4		17		0.908	U	2.06		1.41		2.6		0.336	U	6.67		14.2	U	9.85	U

Compound	P2-SEM-01		P2-SEM-02		P2-SEM-03		P2-SEM-04		P2-SEM-04 Dup		P2-SEM-05		P2-SEM-06		Average	P3-SEM-01		P3-SEM-02	
119-PeCB	C86		C86		C86		C86		C86		C86		C86		C86	C86		C86	
120-PeCB	0.336	U	0.467	U	0.885	U	0.755	U	0.976	U	0.488	U	1.24	U	0.74	ND	U	ND	U
121-PeCB	0.334	U	0.464	U	0.907	U	0.774	U	1	U	0.539	U	1.31	U	0.76	ND	U	ND	U
122-PeCB	0.668	U	0.528	U	1.1	U	1.08	U	1.48	U	0.936	U	0.768	U	0.94	ND	U	ND	U
123-PeCB	0.651	U	0.491	U	0.842	U	0.844	U	1.24	U	0.78	U	0.331	U	0.74	0.309	J	0.358	U
124-PeCB	C107		C107		C107		C107		C107		C107		C107		C107	C107		C107	
125-PeCB	C86		C86		C86		C86		C86		C86		C86		C86	C86		C86	
126-PeCB	0.801	U	0.582	U	1.02	U	1.02	U	1.33	U	0.92	U	0.392	U	0.87	0	U	0	U
127-PeCB	0.683	U	0.541	U	0.922	U	0.91	U	1.25	U	0.764	U	0.699	U	0.82	ND	U	0.127	U
128-HxCB	4.24	C	3.52	C	1.29	U	2.01	U	1.85	U	0.704	U	1.34	UJ	2.14	3.41	U	1.8	U
129-HxCB	26	C	21.6	C	1.28	U	2	U	2.56	J	0.708	U	8.24	C	8.91	20.5	U	11.2	U
130-HxCB	0.805	U	0.925	U	1.7	U	2.65	U	2.44	U	0.964	U	1.88	U	1.62	1.56	U	0.917	U
131-HxCB	0.746	U	0.857	U	1.72	U	2.7	U	2.48	U	1.05	U	1.83	U	1.63	ND	U	ND	U
132-HxCB	0.719	U	0.827	U	1.55	U	2.41	U	2.22	U	0.933	U	2.88		1.65	5.49	U	3.61	U
133-HxCB	0.702	U	0.807	U	1.68	U	2.63	U	2.42	U	0.988	U	1.77	U	1.57	ND	U	ND	U
134-HxCB	1.7		1.48		1.76	U	2.74	U	2.53	U	1.18	U	1.96	U	1.91	1.15	U	0.478	U
135-HxCB	9.8		0.784	U	2.32	U	2.35	U	3.36	U	0.912	U	2.71	C	3.18	5.88	U	3.97	U
136-HxCB	3.23		0.583	U	1.86	U	1.88	U	2.69	U	0.839	U	1.94		1.86	1.75	U	1.31	
137-HxCB	1.63		1.01	J	1.44	U	2.24	U	2.06	U	0.823	U	1.58	U	1.54	0.894	U	0.581	U
138-HxCB	C129		C129		C129		C129		C129		C129		C129		C129	C129		C129	
139-HxCB	0.618	U	0.711	U	1.41	U	2.21	U	2.03	U	0.838	U	1.56	U	1.34	ND	U	ND	U
140-HxCB	C139		C139		C139		C139		C139		C139		C139		C139	C139		C139	
141-HxCB	4.74		3.76		1.4	U	2.19	U	2.01	U	0.807	U	1.47	U	2.34	3.64	U	1.95	U
142-HxCB	0.74	U	0.851	U	1.63	U	2.54	U	2.34	U	1.03	U	1.81	U	1.56	ND	U	ND	U
143-HxCB	1.35		0.74	U	1.54	U	2.41	U	2.22	U	0.899	U	1.65	U	1.54	ND	U	ND	U
144-HxCB	0.665	U	0.795	U	2.25	U	2.28	U	3.26	U	0.927	U	1.58	U	1.68	0.535	U	ND	U
145-HxCB	0.472	U	0.564	U	1.66	U	1.68	U	2.41	U	0.796	U	1.27	U	1.26	ND	U	ND	U
146-HxCB	0.572	U	0.658	U	1.33	U	2.08	U	1.91	U	0.77	UJ	1.55		1.27	2.92	U	1.47	U
147-HxCB	21.6	C	16.3	C	2.82	C	2.19	C	1.96	U	0.835	U	6.76	C	7.50	13.3	U	8.22	U
148-HxCB	0.653	U	0.78	U	2.26	U	2.29	U	3.28	U	1.01	U	1.68	U	1.71	ND	U	ND	U
149-HxCB	C147		C147		C147		C147		C147		C147		C147		C147	C147		C147	
150-HxCB	0.511	U	0.611	U	1.65	U	1.67	U	2.4	U	0.734	U	1.18	U	1.25	ND	U	ND	U
151-HxCB	C135		C135		C135		C135		C135		C135		C135		C135	C135		C135	
152-HxCB	0.53	U	0.634	U	1.86	U	1.88	U	2.7	U	0.846	U	1.34	U	1.40	ND	U	ND	U
153-HxCB	22.8	C	17.5	C	3.67	C	2.36	C	2.47	C	0.692	U	7.34	C	8.12	17.2	U	8.23	U
154-HxCB	0.55	UJ	0.794	J	1.79	U	1.81	U	2.6	U	0.785	U	1.29	U	1.37	0.433	J	ND	U
155-HxCB	0.372	U	0.399	UJ	0.899	U	0.918	U	1.29	U	0.396	U	0.369	U	0.66	0.773		0.457	U
156-HxCB	3.01	C	2.29	C	2.06	U	1.67	U	1.61	U	0.976	U	0.53	UJ	1.74	2.24	U	1.37	U
157-HxCB	C156		C156		C156		C156		C156		C156		C156		C156	C156		C156	
158-HxCB	0.478	U	2.18		1.03	U	1.61	U	1.48	U	0.541	U	1.05	U	1.20	1.88	U	1.08	U

Compound	P2-SEM-01		P2-SEM-02		P2-SEM-03		P2-SEM-04		P2-SEM-04 Dup		P2-SEM-05		P2-SEM-06		Average		P3-SEM-01		P3-SEM-02	
159-HxCB	0.914	U	0.611	U	2.07	U	1.65	U	1.59	U	0.901	U	0.906	U	1.23		ND	U	ND	U
160-HxCB	0.534	U	0.614	U	1.11	U	1.73	U	1.59	U	0.623	U	1.13	U	1.05		ND	U	ND	U
161-HxCB	0.516	U	0.593	U	1.22	U	1.9	U	1.75	U	0.67	U	1.28	U	1.13		ND	U	ND	U
162-HxCB	0.853	U	0.57	U	1.85	U	1.48	U	1.43	U	0.818	U	0.829	U	1.12		ND	U	ND	U
163-HxCB	C129		C129		C129		C129		C129		C129		C129		C129		C129		C129	
164-HxCB	1.91		0.597	U	1.07	U	1.67	U	1.54	U	0.589	U	1.13	U	1.22		1.59	U	0.795	U
165-HxCB	0.567	U	0.652	U	1.23	U	1.93	U	1.77	U	0.707	U	1.31	U	1.17		ND	U	ND	U
166-HxCB	C128		C128		C128		C128		C128		C128		C128		C128		C128		C128	
167-HxCB	1.17		0.916	J	1.68	U	1.32	U	1.25	U	0.778	U	0.396	U	1.07		0.633	U	0	U
168-HxCB	C153		C153		C153		C153		C153		C153		C153		C153		C153		C153	
169-HxCB	0.937	U	0.672	U	1.82	U	1.45	U	1.43	U	0.879	U	0.412	U	1.09		0	U	0	U
170-HpCB	9.08		6.38		1.49	U	1.54	U	2.41	U	0.936	U	2.55		3.48		8.1	U	6.45	U
171-HpCB	0.695	U	2.64	C	1.45	U	1.51	U	2.36	U	0.965	U	1.66	U	1.61		1.83	U	1.12	U
172-HpCB	0.674	U	2.31		1.51	U	1.57	U	2.46	U	0.932	U	1.71	U	1.60		0.988		0.88	J
173-HpCB	C171		C171		C171		C171		C171		C171		C171		C171		C171		C171	
174-HpCB	8.93		7.33		1.4	U	1.45	U	2.27	U	0.881	U	2.19		3.49		6.06	U	4.24	U
175-HpCB	0.77	U	0.784	U	2.03	U	1.53	U	1.87	U	0.867	U	1.74	U	1.37	U	0.28	U	ND	U
176-HpCB	0.605	U	1		1.64	U	1.24	U	1.51	U	0.748	U	1.42	U	1.17		0.697	U	0.596	U
177-HpCB	6.25		0.73	U	1.63	U	1.7	U	2.65	U	0.967	U	1.64	U	2.22		3.76	U	2.13	U
178-HpCB	0.786	U	2.37		2.13	U	1.61	U	1.96	U	0.921	U	1.81	U	1.66		1.44	U	0.786	U
179-HpCB	3.66		0.585	U	1.64	U	1.24	U	1.51	U	0.803	U	1.42	U	1.55		2.45	U	1.41	U
180-HpCB	19.2	C	13.7	C	1.9	JQ	1.2	U	1.87	U	1.79	J	4.02	C	6.24		10.5	U	8.05	U
181-HpCB	0.664	U	0.692	U	1.34	U	1.39	U	2.17	U	0.84	U	1.46	U	1.22	U	ND	U	ND	U
182-HpCB	0.712	U	0.725	U	1.94	U	1.47	U	1.79	U	0.83	U	1.58	U	1.29	U	ND	U	ND	U
183-HpCB	5.34	C	0.643	U	1.42	U	1.48	U	2.31	U	0.858	U	1.48	U	1.93		4.6	U	2.38	U
184-HpCB	0.499	U	0.508	U	1.46	U	1.1	U	1.35	U	0.653	U	1.26	U	0.98	U	ND	U	ND	U
185-HpCB	C183		C183		C183		C183		C183		C183		C183		C183		C183		C183	
186-HpCB	0.576	U	0.587	U	1.57	U	1.19	U	1.45	U	0.685	U	1.33	U	1.06	U	ND	U	ND	U
187-HpCB	10.6		8.54		1.79	U	1.35	U	1.65	U	0.767	U	2.61		3.90		7.39	U	5.04	U
188-HpCB	0.508	U	0.515	U	1.34	U	1.03	U	1.2	U	0.592	U	0.583	U	0.82	U	ND	U	ND	U
189-HpCB	0.392	U	0.729	U	1.11	U	1.33	U	1.84	U	0.774	U	0.436	U	0.94	U	0	U	0.179	U
190-HpCB	2.23		0.534	U	1.12	U	1.16	U	1.81	U	0.703	U	1.2	U	1.25		1.08	U	0.952	U
191-HpCB	0.516	U	0.537	U	1.12	U	1.17	U	1.82	U	0.72	U	1.25	U	1.02	U	ND	U	ND	U
192-HpCB	0.547	U	0.57	U	1.12	U	1.16	U	1.82	U	0.71	U	1.2	U	1.02	U	ND	U	ND	U
193-HpCB	C180		C180		C180		C180		C180		C180		C180		C180		C180		C180	
194-OcCB	0.575	U	4.14		2.07	U	1.74	U	2.51	U	1.19	U	1.73	U	1.99	U	2.43	U	1.76	U
195-OcCB	0.623	U	1.02	U	2.42	U	2.03	U	2.94	U	1.28	U	1.91	U	1.75	U	0.735		0.805	J
196-OcCB	2.29		0.787	U	2.19	U	2.28	U	1.99	U	1.1	U	1.67	U	1.76		1.48		1.17	
197-OcCB	0.619	U	0.583	U	3.55	U	3.7	U	3.23	U	0.806	U	1.27	U	1.97	U	0.527		ND	U
198-OcCB	5.77	C	0.788	U	2.12	U	2.21	U	1.93	U	1.07	U	2.51	C	2.34		3.29		2.27	

Compound	P2-SEM-01	P2-SEM-02	P2-SEM-03	P2-SEM-04	P2-SEM-04 Dup	P2-SEM-05	P2-SEM-06	Average	P3-SEM-01	P3-SEM-02
199-OcCB	C198	C198	C198	C198	C198	C198	C198	C198	C198	C198
200-OcCB	C197	C197	C197	C197	C197	C197	C197	C197	C197	C197
201-OcCB	0.645 UJ	0.607 U	1.75 U	1.82 U	1.59 U	0.887 U	1.35 U	1.24 U	0.39 U	ND U
202-OcCB	0.641 U	0.659 U	1.52 U	1.65 U	1.41 U	0.766 U	0.61 U	1.04 U	0.703 U	0.411 U
203-OcCB	3.09	0.723 U	1.9 U	1.98 U	1.73 U	0.93 U	1.45 U	1.69	1.78 U	1.18 U
204-OcCB	0.652 U	0.614 U	1.79 U	1.87 U	1.63 U	0.89 U	1.38 U	1.26 U	ND U	ND U
205-OcCB	0.498 U	0.764 U	1.76 U	1.42 U	2.1 U	0.986 U	0.671 U	1.17 U	ND U	ND U
206-NoCB	3.45	2.76	2.13 U	2.51 U	2.62 U	1.23 U	0.803 U	2.21	1.12 U	1.22
207-NoCB	0.789 U	0.69 U	1.89 U	2.28 U	2.25 U	1.08 U	1.52 U	1.50 U	0.236 U	ND U
208-NoCB	1.57	0.738 U	1.73 U	2.15 U	2.01 U	0.987 U	0.709 U	1.41	ND U	0.485 J
209-DeCB	2.49	1.29 U	2.23 U	1.74 U	2.61 U	0.945 U	1.02 U	1.76	1.02 U	1.14 U
Total of PCB Congeners	592.0	381.7	229.7	218.6	238.7	147.8	421.6	318.6	573.4	402.0
	ng/kg								ng/kg	
TEQ (PCB)	0.050	0.037	0.061	0.059	0.075	0.051	0.022	0.051	0.002	0.001
DIOXINS-FURANS	pg/g								pg/g	
1,2,3,4,6,7,8-HpCDD	1.31 JA	2.63 U	0.548 JA	0.425 U	0.394 U	0.474 J	0.31 J	0.870	5 U	12.4
1,2,3,4,6,7,8-HpCDF	0.72 JA	1.38 U	0.38 U	0.425 U	0.252 JA	0.292 J	0.425 U	0.553	5 U	11000 J
1,2,3,4,7,8,9-HpCDF	0.887 U	1.72 U	0.454 U	0.425 U	0.394 U	0.496 U	0.425 U	0.686	5 U	396
1,2,3,4,7,8-HxCDD	0.469 U	0.434 U	0.385 U	0.425 U	0.394 U	0.421 U	0.425 U	0.422	5 U	5 U
1,2,3,4,7,8-HxCDF	0.444 U	0.434 U	0.38 U	0.425 U	0.394 U	0.108 J	0.425 U	0.373	5 U	3600 J
1,2,3,6,7,8-HxCDD	0.486 U	0.434 U	0.399 U	0.425 U	0.394 U	0.421 U	0.425 U	0.426	5 U	5 U
1,2,3,6,7,8-HxCDF	0.444 U	0.434 U	0.38 U	0.425 U	0.394 U	0.121 J	0.425 U	0.375	5 U	652
1,2,3,7,8,9-HxCDD	0.474 U	0.434 U	0.388 U	0.425 U	0.394 U	0.421 U	0.425 U	0.423	5 U	5 U
1,2,3,7,8,9-HxCDF	0.444 U	0.434 U	0.38 U	0.425 U	0.394 U	0.421 U	0.425 U	0.418	5 U	39.3
1,2,3,7,8-PeCDD	0.444 U	0.434 U	0.38 U	0.425 U	0.394 U	0.421 U	0.43 U	0.418	5 U	5 U
1,2,3,7,8-PeCDF	0.444 U	0.434 U	0.38 U	0.425 U	0.394 U	0.123 J	0.425 U	0.375	5 U	95.2
2,3,4,6,7,8-HxCDF	0.444 U	0.434 U	0.38 U	0.425 U	0.394 U	0.421 U	0.425 U	0.418	5 U	173
2,3,4,7,8-PeCDF	0.444 U	0.434 U	0.38 U	0.425 U	0.394 U	0.174 J	0.425 U	0.382	5 U	173
2,3,7,8-TCDD	0.833 U	0.625 U	0.72 U	0.338 U	0.287 U	0.461 U	0.248 U	0.502	1 U	1 U
2,3,7,8-TCDF	0.502 U	0.336 U	0.369 U	0.184 U	0.15 A	0.322 U	0.189 U	0.293	1 U	5.5
OCDD	8.74 A	1.13 U	5.97 A	0.851 U	0.788 U	2.08	0.851 U	2.916	10 U	21.4
OCDF	1.31 U	0.932 U	1.11 U	0.851 U	0.788 U	1.24 U	0.851 U	1.012	10 U	9930 J
Total HpCDDs	2.84	2.63 U	1.11	0.237	0.394 U	0.958	0.31	1.211	5 U	24.6
Total HpCDFs	0.72	1.72 U	0.454 U	0.425 U	0.252	0.292	0.425 U	0.613	5 U	12500
Total HxCDDs	0.486 U	0.434 U	0.399 U	0.425 U	0.394 U	0.722	0.425 U	0.469	5 U	17.7
Total HxCDFs	0.522	0.434 U	0.38 U	0.425 U	0.394 U	0.686	0.425 U	0.467	5 U	6610
Total PeCDDs	0.444 U	0.434 U	0.38 U	0.425 U	0.394 U	0.951 J	0.43 U	0.494	5 U	11.8
Total PeCDFs	0.444 U	0.434 U	0.38 U	0.425 U	0.394 U	1.13 J	0.425 U	0.519	5 U	1420
Total TCDDs	0.833 U	0.625 U	0.72 U	0.338 U	0.287 U	0.494	0.248 U	0.506	1 U	8.53

Compound	**P2-SEM-01**	**P2-SEM-02**	**P2-SEM-03**	**P2-SEM-04**	**P2-SEM-04 Dup**	**P2-SEM-05**	**P2-SEM-06**	**Average**	**P3-SEM-01**	**P3-SEM-02**
Total TCDFs	0.502 U	0.336 U	0.369 U	0.184 U	0.15	1.83	0.189 U	0.509	1 U	445
Total of D/F Congeners	16.84	9.11	11.27	4.59	4.24	10.38	4.58	8.72	52	9951
	ng/kg								ng/kg	
TEQ (Dioxin)	0.972	0.998	0.818	0.663	0.608	0.690	0.622	0.767	11.406	626.3
Total TEQ (D/F+PCBs)	1.021	1.034	0.879	0.722	0.683	0.741	0.644	0.818	11.408	626.3
METALS	mg/kg								mg/kg	
Arsenic	2.3 U	2.1 U	2.1 U	2.1 U	2 U	2 U	2.2 U	2.1 U	16.3	6.37
Barium	159	166	235	222	216	20 U	22 U	148.6	251	124
Cadmium	0.66	0.58	0.83	0.8	0.77	0.51 U	0.55 U	0.7	0.535 U	0.162 U
Chromium	101	103	125	116	114	7.2	11.6	82.5	231	43.2
Cobalt	7.6	7.6	10.7	10.2	9.3	5.1 U	5.5 U	8.0	11	4.32
Copper	93.5	101	150	141	138	7.3	12.9	92.0	150	65
Lead	25.2	18	45.1	41.6	40.2	8.9	11.3	27.2	19.9	14.6
Manganese	242	237	315	300	290	14.7	27.9	203.8	787	240
Mercury	0.035 U	0.034 U	0.033 U	0.033 U	0.033 U	0.031 U	0.032 U	0.033 U	0.0244	0.00426 J
Nickel	29.7	27.7	38.2	36.1	34	4.1 U	4.4 U	24.9	67.1	25.1
Selenium	2.3 U	2.1 U	2.1 U	2.1 U	2 U	2 U	2.2 U	2.1 U	1.98 U	0.364 U
Silver	1.1 U	1 U	1.1 U	1 U	0.99 U	1 U	1.1 U	1.0 U	0.826 J	0.445 U
Zinc	88.1	79.6	220	203	200	14.1	20.9	118.0	41.7	34.8
PESTICIDES	µg/kg								µg/kg	
4,4'-DDD	0.36 U	0.35 U	0.33 U	0.32 U	0.32 U	0.34 U	0.33 UJ	0.336 U	1.09 U	1.06 U
4,4'-DDE	0.37 U	0.36 U	0.34 U	0.33 U	0.34 U	0.35 U	0.34 U	0.347 U	1.09 U	1.06 U
4,4'-DDT	0.45 U	0.44 U	0.42 U	0.41 U	0.41 U	0.43 U	0.42 U	0.426 U	0.956 U	0.93 U
Dieldrin	0.37 U	0.37 U	0.35 U	0.34 U	0.34 U	0.36 U	0.35 U	0.354 U	0.602 U	0.585 U
SVOCs	µg/kg								µg/kg	
Acenaphthene	0.6 U	0.59 U	0.56 U	0.56 U	0.56 U	0.57 U	0.57 U	0.57 U	0.882 U	0.946 U
Acenaphthylene	0.37 U	0.37 U	0.35 U	0.35 U	0.35 U	0.36 U	0.36 U	0.36 U	0.776 U	0.833 U
Anthracene	0.26 U	0.26 U	0.24 U	0.24 U	0.24 U	0.25 U	0.25 U	0.25 U	1.24 U	1.33 U
Benzo(a)anthracene	0.23 U	0.22 U	0.21 U	0.21 U	0.21 U	0.22 U	0.22 U	0.22 U	1.12 U	1.2 U
Benzo(a)pyrene	0.55 U	0.54 U	0.51 U	0.51 U	0.51 U	0.52 U	0.52 U	0.52 U	0.99 U	1.06 U
Benzo(b)fluoranthene	1.4 UJ	1.4 U	1.3 U	1.3 U	1.3 U	1.3 U	1.3 U	1.33 U	1.69 U	1.81 U
Benzo(g,h,i)perylene	0.62 U	0.61 U	0.58 U	0.58 U	0.58 U	0.59 U	0.59 U	0.59 U	1.53 U	1.64 U
Benzo(k)fluoranthene	0.62 U	0.61 U	0.58 U	0.57 U	0.57 U	0.59 U	0.59 U	0.59 U	1.73 U	1.86 U
bis(2-Ethylhexyl)phthalate	24 U	24 U	22 U	22 U	22 U	23 U	23 U	22.86 U	5.86 UJ	6.29 UJ
Chrysene	0.41 U	0.41 U	0.38 U	0.38 U	0.38 U	0.39 U	0.39 U	0.39 U	0.645 U	0.692 U
Dibenzo(a,h)anthracene	0.48 U	0.47 U	0.45 U	0.44 U	0.44 U	0.46 U	0.46 U	0.46 U	0.428 U	3459 U
Di-n-octyl phthalate	7.3 U	7.2 U	6.8 U	6.8 U	6.8 U	7 U	7 U	6.99 U	5.86 U	6.29 U

Compound	P2-SEM-01		P2-SEM-02		P2-SEM-03		P2-SEM-04		P2-SEM-04 Dup		P2-SEM-05		P2-SEM-06		Average		P3-SEM-01		P3-SEM-02	
Fluoranthene	0.27	U	0.26	U	0.25	U	0.25	U	0.25	U	0.26	U	0.26	U	0.26	U	0.984	U	1.06	U
Fluorene	0.68	U	0.67	U	0.63	U	0.63	U	0.63	U	0.65	U	0.65	U	0.65	U	0.908	U	0.975	U
Indeno(1,2,3-cd)pyrene	0.57	U	0.56	U	0.53	U	0.53	U	0.53	U	0.55	U	0.55	U	0.55	U	0.97	U	1.04	U
Naphthalene	0.44	U	0.43	U	0.41	U	0.41	U	0.41	U	0.42	U	0.42	U	0.42	U	1.23	U	1.32	U
Phenanthrene	0.39	U	0.39	U	0.37	U	0.37	U	0.37	U	0.37	U	0.37	U	0.38	U	1.78	U	1.91	U
Pyrene	0.29	U	0.29	U	0.27	U	0.27	U	0.27	U	0.28	U	0.28	U	0.28	U	1.59	U	1.71	U

Notes: "P2" refers to Phase II of the overall project conducted in December 2006. "P3" refers to the testing conducted May 2007.
"SEM" refers to "Solid Ecomelt" sample.
U - Analyte was not detected. The associated value is the estimated detection limit.
J - The analyte is present, but the concentration is below the quantitation limit. The concentration is estimated.
UJ - The detection limit is estimated.
C - The isomer coeluted with another of its homologue group. If followed by a number, the number indicates the lowest numbered congener among the coelution set.
"-" The sample was not analyzed for that analyte.
* The total of these analytes includes non-detected values at the detection limit

Results of Leaching Tests Conducted on Samples of Ecomelt from Passaic River Sediment (Dec 06)

Compound	Class	P2-SEM-01	P2-SEM-02	P2-SEM-03	P2-SEM-04	P2-SEM-05	P2-SEM-06	Average
SPLP Metals		mg/L						
Arsenic	SPLP	0.008 U	-	0.008 U	-	-	0.008 U	0.00800 U
Barium	SPLP	1 U	-	1 U	-	-	1 U	1.00000 U
Cadmium	SPLP	0.004 U	-	0.004 U	-	-	0.004 U	0.00400 U
Chromium	SPLP	0.01 U	-	0.01 U	-	-	0.01 U	0.01000 U
Cobalt	SPLP	0.05 U	-	0.05 U	-	-	0.05 U	0.05000 U
Copper	SPLP	0.025 U	-	0.025 U	-	-	0.025 U	0.02500 U
Lead	SPLP	0.01 U	-	0.017	-	-	0.032	0.01967
Manganese	SPLP	0.084	-	0.021	-	-	0.023	0.04267
Mercury	SPLP	0.0002 U	-	0.00029	-	-	0.0002 U	0.00023
Nickel	SPLP	0.043	-	0.04 U	-	-	0.04 U	0.04100
Selenium	SPLP	0.05 U	-	0.05 U	-	-	0.05 U	0.05000 U
Silver	SPLP	0.01 U	-	0.01 U	-	-	0.01 U	0.01000 U
Zinc	SPLP	0.13	-	0.1 U	-	-	0.12	0.11667
SPLP Pesticides								
4,4'-DDD	SPLP	0.000017 U	-	0.000017 U	-	-	0.000017 U	0.00002 U
4,4'-DDE	SPLP	0.0000041 U	-	0.0000041 U	-	-	0.0000041 U	0.00000 U
4,4'-DDT	SPLP	0.000018 U	-	0.000018 U	-	-	0.000018 U	0.00002 U
Dieldrin	SPLP	0.000013 U	-	0.000013 U	-	-	0.000013 U	0.00001 U
SPLP SVOCs								
Benzo(a)anthracene	SPLP	0.000019 U	-	0.000019 U	-	-	0.000019 U	0.00002 U
Benzo(a)pyrene	SPLP	0.0000039 U	-	0.0000039 U	-	-	0.0000039 U	0.00000 U
Benzo(b)fluoranthene	SPLP	0.000017 U	-	0.000017 U	-	-	0.000017 U	0.00002 U
Benzo(k)fluoranthene	SPLP	0.000021 U	-	0.000021 U	-	-	0.000021 U	0.00002 U
bis(2-Ethylhexyl)phthalate	SPLP	0.00013 U	-	0.00013 U	-	-	0.00013 U	0.00013 U
Chrysene	SPLP	0.0000093 U	-	0.0000093 U	-	-	0.0000093 U	0.00001 U
Indeno(1,2,3-cd)pyrene	SPLP	0.0000085 U	-	0.0000085 U	-	-	0.0000085 U	0.00001 U
TCLP Metals								
Arsenic	TCLP	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
Barium	TCLP	1 U	1 U	1 U	1 U	1	1 U	1.0
Cadmium	TCLP	0.0092	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.0
Chromium	TCLP	0.01	0.01 U	0.01 U	0.01 U	0.014	0.011	0.0
Cobalt	TCLP	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U	0.1 U
Copper	TCLP	0.15	0.025 U	0.025	0.025 U	0.034	0.026	0.0
Lead	TCLP	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
Manganese	TCLP	0.21	0.071	0.037	0.032	0.037	0.034	0.1
Mercury	TCLP	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0 U
Nickel	TCLP	0.12	0.04	0.04 U	0.04 U	0.04 U	0.04 U	0.1

Compound	Class	P2-SEM-01	P2-SEM-02	P2-SEM-03	P2-SEM-04	P2-SEM-05	P2-SEM-06	Average
Selenium	TCLP	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
Silver	TCLP	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.0 U
Zinc	TCLP	0.7	0.31	0.16	0.13	0.22	0.17	0.3
TCLP Pesticides								
4,4'-DDD	TCLP	0.00017 U	0.00017 U	0.000017 UJ	0.00017 U	0.00017 U	0.00017 U	0.000145 U
4,4'-DDE	TCLP	0.000041 U	0.000041 U	0.000041 U	0.000041 U	0.000041 U	0.000041 U	0.000041 U
4,4'-DDT	TCLP	0.00018 U	0.00018 U	0.00018 U	0.00018 U	0.00018 U	0.00018 U	0.000180 U
Dieldrin	TCLP	0.000013 U	0.00013 U	0.00013 U	0.00013 U	0.00013 U	0.00013 U	0.000111 U
TCLP SVOCs								
Acenaphthene	TCLP	0.000054 U	0.000054 U	0.000054 U	0.000054 U	0.000054 U	0.000054 U	0.0000540 U
Acenaphthylene	TCLP	0.000021 U	0.000021 U	0.000021 U	0.000021 U	0.000021 U	0.000021 U	0.0000210 U
Anthracene	TCLP	0.000029 U	0.000029 U	0.000029 U	0.000029 U	0.000029 U	0.000029 U	0.0000290 U
Benzo(a)anthracene	TCLP	0.00019 U	0.00019 U	0.00019 U	0.00019 U	0.00019 U	0.00019 U	0.0001900 U
Benzo(a)pyrene	TCLP	0.000039 U	0.000039 U	0.000039 U	0.000039 U	0.000039 U	0.000039 U	0.0000390 U
Benzo(b)fluoranthene	TCLP	0.00017 U	0.00017 U	0.00017 U	0.00017 U	0.00017 U	0.00017 U	0.0001700 U
Benzo(g,h,i)perylene	TCLP	0.000088 U	0.000088 U	0.000088 U	0.000088 U	0.000088 U	0.000088 U	0.0000880 U
Benzo(k)fluoranthene	TCLP	0.00021 U	0.00021 U	0.00021 U	0.00021 U	0.00021 U	0.00021 U	0.0002100 U
bis(2-Ethylhexyl)phthalate	TCLP	0.0013 U	0.0013 U	0.0013 U	0.0013 U	0.0013 U	0.0013 U	0.0013000 U
Chrysene	TCLP	0.000093 U	0.000093 U	0.000093 U	0.000093 U	0.000093 U	0.000093 U	0.0000930 U
Dibenzo(a,h)anthracene	TCLP	0.00012 U	0.00012 U	0.00012 U	0.00012 U	0.00012 U	0.00012 U	0.0001200 U
Di-n-octyl phthalate	TCLP	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.0020000 U
Fluoranthene	TCLP	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002000 U
Fluorene	TCLP	0.000077 U	0.000077 U	0.000077 U	0.000077 U	0.000077 U	0.000077 U	0.0000770 U
Indeno(1,2,3-cd)pyrene	TCLP	0.000085 U	0.000085 U	0.000085 U	0.000085 U	0.000085 U	0.000085 U	0.0000850 U
Naphthalene	TCLP	0.000082 U	0.000082 U	0.000082 U	0.000082 U	0.000082 U	0.000082 U	0.0000820 U
Phenanthrene	TCLP	0.000099 U	0.000099 U	0.000099 U	0.000099 U	0.000099 U	0.000099 U	0.0000990 U
Pyrene	TCLP	0.00011 U	0.00011 U	0.00011 U	0.00011 U	0.00011 U	0.00011 U	0.0001100 U

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"-" The sample was not analyzed for that analyte.
* The total of these analytes includes non-detected values at the detection limit.